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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 1088

Washington, D. C. PROFESSIONAL PAPER July, 1922

ZYGOBOTHRIA NIDICOLA, AN IMPORTANT PARASITE OF THE BROWN-TAIL MOTH.

By C. F. W. Muesebeck,[1] *Scientific Assistant, Gipsy Moth and Brown-tail Moth Investigations, Bureau of Entomology.*

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INTRODUCTION.

One of the most effective factors in the control of the brown-tail moth (*Euproctis chrysorrhoea L.*) in the United States is the introduced tachinid fly *Zygobothria nidicola* Townsend. Strangely enough this European parasite had not been described at the time it was first obtained in this country. The first adults were reared at the Gipsy Moth Laboratory, then located at North Saugus, Mass., in the summer of 1906, from brown-tail moth caterpillars that had been received from Europe during the preceding winter. The specimens were referred to Mr. C. H. T. Townsend, of the Bureau of Entomology, United States Department of Agriculture, for identification. After some correspondence with European authorities, to whom also specimens were submitted for examination, Mr. Townsend concluded that the species was new, and subsequently described it under the name *Zygobothria nidicola.*[2]

Much difficulty was experienced in rearing adults of the parasite for colonization from imported brown-tail moth larvæ. This was due to the great mortality among the caterpillars, particularly from

[1] Special acknowledgments are due Mr. A. F. Burgess, in charge of Gipsy Moth and Brown-tail Moth Investigations, for helpful criticism of this bulletin, and Messrs. S. S. Crossman and R. T. Webber, of the Gipsy Moth Laboratory, Melrose Highlands, Mass., for many suggestions during the prosecution of the work.

[2] Townsend, Charles H. T. The taxonomy of the muscoidean flies, including descriptions of new genera and species. *In* Smithsonian Miscellaneous Collections, v. 51, p. 99–101. 1908.

disease, before the parasites completed their development. Despite the discouraging results of the breeding work, however, *Z. nidicola* became established, and by 1910 had definitely taken its place in our fauna. The trying experiences of the laboratory force, in their attempts to establish this parasite, are interestingly recounted by Howard and Fiske.[3]

DISTRIBUTION IN THE UNITED STATES.

Because it evidently has no hosts other than the brown-tail moth the parasite must necessarily remain within the area over which this insect occurs; but within these limits it appears to be widely distributed, although it is relatively less abundant in the sections where very low temperatures are reached during the winter. It has been recovered from Rhode Island to northeastern Maine—very abundantly in the former region, sparingly in the latter. This wide dissemination, within some seven or eight years, is very largely the result of natural spread, since there has been little artificial colonization of this species.

LIFE CYCLE OF THE BROWN-TAIL MOTH.

Before taking up in detail the biology of the parasite it will be well to review briefly the life cycle of its host. During July the female brown-tail moth deposits her eggs on the underside of a leaf of one of the favored food plants—apple, pear, oak, or wild cherry. Usually the terminal leaves of the uppermost shoots of the tree are selected for oviposition. The eggs hatch in about three weeks and the small caterpillars feed on the epidermis of the leaves, preferring the terminal ones, which they gradually tie together with a large amount of silk. This process is slow, but ultimately a firm, tough web, about 3 or 4 inches long, is formed. By this time the majority of the slowly growing larvæ are in the third stage and are ready for hibernation. In the spring feeding begins as soon as the buds open, and continues until the middle of June, when cocoons are formed and pupation occurs. Moths issue during the first half of July, and, after a few days, lay their eggs. There is only one generation annually.

LIFE HISTORY AND BIOLOGY OF THE PARASITE.

EMERGENCE AND LONGEVITY OF THE ADULTS.

Adults of *Z. nidicola* appear during the latter half of July. They are very sturdy flies (Fig. 1) and endure unfavorable conditions well, normally living for a period of at least several weeks. Some

[3] HOWARD, L. O., and FISKE, W. F. THE IMPORTATION INTO THE UNITED STATES OF THE PARASITES OF THE GIPSY MOTH AND THE BROWN-TAIL MOTH. U. S. Dept. Agr., Bur. Ent. Bul. 91, p. 289–295. 1911.

specific data with regard to the length of life were obtained from laboratory experiments in which various types of cages were used. These consisted of: (1) Plain glass cylinders, measuring 50 by 200 mm., closed at one end; (2) ordinary shell vials, 22 by 100 mm.; and (3) a wooden cage, which had been successfully used by Mr. J. J. Culver in his life-history studies upon *Compsilura concinnata* Meigen, a tachinid parasite of both the brown-tail moth and the gipsy moth.

The glass cylinders were rather satisfactory for two to five flies each, when a bit of crunched crêpe paper was placed inside to afford the flies a good footing, but it was necessary to change the cylinders

FIG. 1.—Adult male of *Zygobothria nidicola*.

every few days because they quickly became dirty and sticky, and this involved a good deal of work. This objection applied to the shell vials as well, which in addition were found to be too small even for individual flies. The wooden cage was by far the most satisfactory. It measures about 12 inches square and 4 inches high, and is fitted with a cloth bottom to facilitate cleaning after each experiment; the top is a piece of window glass of the proper size. One-inch holes bored in the sides of the box and covered with fine wire gauze insure good ventilation. Another opening of the same size is fitted with a cork and is used for introducing the flies. Feeding is facilitated by the use of a larger opening, about 2 inches in diameter, which can be closed with a wooden stopper. After the flies were placed in this cage they were left entirely alone save for the feeding, which

was done on alternate days. This process merely involved slipping a narrow strip of blotting paper, which had been soaked in a mixture of honey and water, into the cage, and removing the old strip which had been placed there two days before.

Only a small proportion of the flies confined in the glass cylinders or shell vials lived from 25 to 28 days, and then only upon receiving particularly good care; those in the wooden cages which were given comparatively little attention lived five weeks and more. Two males and one female, which were confined in one of these wooden cages, were apparently in as good condition at the end of a 40-day period, when the experiment was discontinued, as when first placed in the box; several larger lots did about as well. The data obtained certainly demonstrate the ability of *Z. nidicola* to live a long time; and since even at best the artificial methods of the laboratory probably can not provide the equivalent of natural conditions, it seems safe to assume that in nature the average life of *Z. nidicola* is at least 25 to 30 days.

EMBRYONIC DEVELOPMENT.

Mating takes place within a few hours after emergence, sometimes even before either fly has fed. Following impregnation the uterus of the female fly gradually becomes much elongated and coiled, ultimately attaining a length of 7.5 to 8 mm., which is about the length of the entire insect. This enlargement results from the stretching of the walls of the organ as the enormous numbers of fertilized eggs pass into it and arrange themselves in more or less regular spiral layers. Embryonic development requires from seven to eight days. At the end of this period the lower part of the uterus contains a considerable number of maggots, each still enclosed within its egg-chorion. From 12 to 16 days after impregnation two-thirds of the 600 or more eggs in the uterus have fully formed first-stage maggots within them, if the fly has not been ovipositing as rapidly as they have developed.

OVIPOSITION.

The female fly prefers as its victims brown-tail moth caterpillars that are from several days to two weeks old, but even those just out of the egg are often successfully parasitized. Most of the oviposition by this species takes place during the first three weeks of August, in normal seasons.

Oviposition was readily obtained in the laboratory by confining a fertilized female fly in a shell vial with a few brown-tail moth larvæ that had been placed upon a small piece of cherry leaf. Having found the caterpillars, the parasite manifested much interest, passing slowly from one larva to another and inspecting each minutely. Then, with her face but a few millimeters from one of

the caterpillars, she slowly and deliberately pushed her abdomen downward and forward until the ovipositor plates were even with her face. With a quick movement the ovipositor was then pushed beneath the larva, and an egg with a first-stage maggot within it was deposited. The egg is almost invariably placed on the venter of the host, and usually occupies a transverse position between two pairs of true legs, or, less frequently, between two pairs of prolegs. Occasionally an egg is placed on the dorsum by accident, but in such cases the parasitic maggot is unable to enter its host—at least this was true of instances under observation in the laboratory. The explanation probably is to be found in the thicker skin of the dorsum, which is not so easily pierced by the small maggot.

Although only one parasite can complete its development in one host larva, the fly uses no discrimination when depositing her eggs; she places eggs as readily upon larvæ already having eggs upon them as upon those not yet attacked. From five to eight eggs have been found on one caterpillar. That this takes place under field conditions as well as in the laboratory has been disclosed by dissections; from 6 to 10 first-stage maggots of the parasite have been not uncommonly dissected from single field-collected brown-tail moth caterpillars.

EGG.

As deposited, the egg measures from 0.42 to 0.45 mm. in length by 0.11 to 0.12 mm. in width; the maggot within is 0.33 to 0.35 mm. long and 0.08 to 0.09 mm. broad. In form the egg is elongate-oval, somewhat narrowed at the posterior end, and concave on the lower side; in color it is whitish. The thin and delicate chorion is transparent. When viewed from above the egg appears opaque; this is due to what seems to be a special layer of protecting tissue just inside the chorion; it is limited to the posterior three-fourths of the egg, and occurs only above the maggot. It is peculiarly reticulated, being marked off into very slender hexagons, the outermost of which are incomplete. Its position suggests its function to be that of affording protection to the young maggot before the latter succeeds in boring into its host.

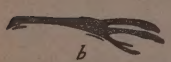
ENTRANCE OF MAGGOT INTO HOST.

Having been placed upon its host the parasitic maggot begins to cut through the thin egg chorion that confines it, and as soon as this is done it bores into the caterpillar. The posterior end of the parasite remains inside the eggshell until the opening into the host has been made; when this has been accomplished it requires but a fraction of a second for the maggot to pull its whole body into the caterpillar. In one case under observation the entire process of cutting through the egg chorion and the host skin and entering the

brown-tail moth caterpillar was completed within 10 minutes after the egg had been deposited. From many observations it appears that normally 20 to 30 minutes elapse between oviposition and the entrance of the parasitic larva into its host. Often the caterpillar makes vigorous attempts to destroy the maggot before the latter has made its way inside, and occasionally these efforts are successful, particularly if the egg of the parasite was deposited near the posterior end of the host. In this case the brown-tail moth larva, by doubling its body, can reach the parasite and crush it with its mandibles.

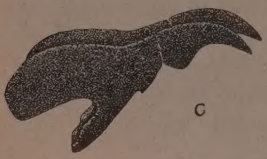
a

FIRST-STAGE MAGGOT OF THE PARASITE.

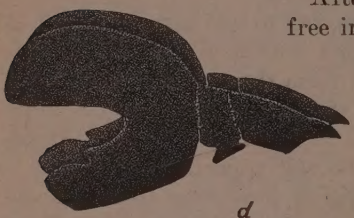


b

The most striking thing about the parasitic maggot at the time it enters the caterpillar is the strongly chitinized mouth hook (Fig. 2, *a*, *b*). It is simple in this stage, consisting of a single apical tooth and comparatively narrow, divided, posterior plates, the entire mouth hook being one solid structure. A pair of rather indistinct spiracles open on the last body segment.



c



d

FIG. 2.—*Zygobothria nidicola: a*, Mouth hook of first-stage maggot, dorsal aspect; *b*, mouth hook of first-stage maggot, lateral aspect; *c*, mouth hook of second-stage maggot; *d*, mouth hook of third-stage maggot.

After entering its host the parasite lives free in the body cavity for about 10 to 14 days and feeds on the fat body of the slowly developing caterpillar. Then it enters the œsophagus and remains here throughout its hibernation period of about nine months. It may lie longitudinally disposed or it may lie obliquely; apparently no particular part of the œsophagus is preferred, but usually the head of the parasite is directed toward the anterior end of its host. From dissections it appears that the maggot lies in a cyst against the inner wall of the intestine. Here, of course, it does not feed at all.

Rather severe competition is encountered from two hymenopterous parasites, *Apanteles lacteicolor* Viereck and *Meteorus versicolor* Wesmael, which also hibernate in the small brown-tail moth caterpillars. The presence of either of these parasites in the same host with Zygobothria produces the death of the latter. The exact nature of this peculiar influence exerted by the hymenopterous parasites upon the dipterous larva has not yet been demonstrated. Death

may perhaps result from a direct secretion of the hymenopterous species, or it may follow some special reaction on the part of the host; at no time has evidence of active combat been found.

In the spring the brown-tail moth larvæ that have hibernated begin feeding as soon as the buds open, but the Zygobothria maggots, in their cysts in the œsophagus, remain inactive for several weeks longer. It is not until late May and early June, when the host larvæ have molted into the last stage, that the parasite leaves its cyst in the fore-intestine and again enters the body cavity of the caterpillar to feed. Invariably it works its way at once to the posterior end of the host. After three or four days it is found to have established communication with the outside air through an opening in the integument of the brown-tail moth larva. From this minute, more or less circular opening there proceeds a rapid growth of the integument into the body cavity. This ingrowth takes the form of a funnel, within which the parasite lies, its posterior end directed toward the small opening, its anterior end free in the fat and fluids of its host. Thus the parasite has procured for itself an independent air supply. On the outside of the integumental funnel layers of soft tissue, evidently consisting of hypodermal cells, leucocytes, and compressed fat cells of the caterpillar, are gradually laid down, one upon another, until a thick, fleshy wall has been formed about the funnel.

The manner in which the opening through the body wall of the brown-tail moth larva is effected was not observed. Possibly it results from irritation by the spines at the caudal end of the parasitic maggot.

SECOND-STAGE MAGGOT OF THE PARASITE.

Very soon after becoming established in the posterior end of its host, and in the integumental funnel, the parasite molts into the second stage. The first-stage skin is pushed back upon the funnel where it is readily detected by the presence of the mouth hook. The second-stage maggot is distinguished from that of the first stage by its larger size, the much heavier mouth hook, and the presence of a pair of anterior spiracles, often difficult to locate, situated between the second and third body segments. Instead of the single apical tooth of the first stage the mouth hook now has two teeth, the pharyngeal skeleton having divided longitudinally over its anterior half; furthermore, there is now an indistinct transverse joint near the middle of this anterior portion. The posterior plates of the mouth hook are much stouter than in the first stage.

Throughout this instar, which requires from 8 to 12 days, the maggot remains in the integumental funnel. It grows rapidly during this period so that it measures about 4 mm. in length when ready to molt into the third and last larval stage. By this time the host has spun its cocoon.

THIRD-STAGE MAGGOT OF THE PARASITE.

When the second-stage skin is molted it is pushed back upon the funnel, as was that of the first stage; the mouth hooks of the two instars at this time are easily seen on the mass of yellowish tissue that surrounds the chitinous funnel itself. The particular points of difference between the second and third stage maggots are the larger size of the latter and its much heavier mouth hook. The mouth hook is divided longitudinally as in the second stage, but there are now two joints in the anterior part of the skeleton, one near the middle, corresponding to the single joint of the second stage, and another near the base of the very broad posterior plates. The anterior spiracles, opening between the second and third body segments, are much more distinct than in the second instar.

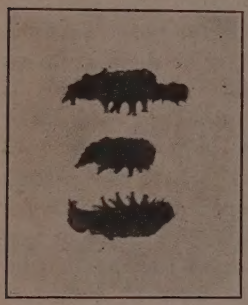


FIG. 3.—Brown-tail moth caterpillars containing puparia of *Zygobothria nidicola*.

This stage is the shortest of the three, requiring only four or five days. The host larva is killed just before the end of this period, with the destruction of its vital organs, and the parasite forms its puparium in the integumental funnel inside the host.

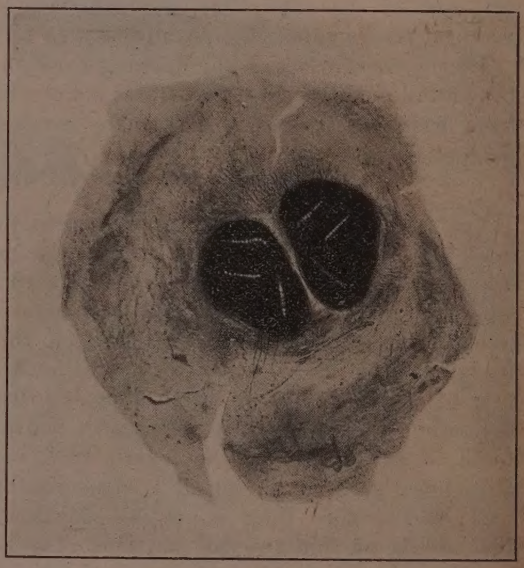


FIG. 4.—Anal stigmata of puparium of *Zygobothria nidicola*.

The puparium is about 8 mm. long and is dark brownish red in color; the posterior end is a little depressed, and the two anal stigmata (Fig. 4) within the depression are slightly elevated. Dead caterpillars that contain puparia of *Z. nidicola* (Fig. 3) are easily detected; they are greatly shortened, being scarcely longer than the puparia within, and are slightly inflated.

The period spent in the puparium averages from 25 to 30 days, after which the flies appear, some 8 to 16 days prior to the hatching

of the eggs of the brown-tail moth. This is just time enough to insure fertilization and development of the ova. Thus the life cycle of *Zygobothria nidicola* fits perfectly into that of its host.

ECONOMIC IMPORTANCE OF THE PARASITE.

Although *Zygobothria nidicola* has only one generation a year, and is handicapped by its absolute dependence upon the brown-tail moth, it has become a common species in New England. This means that it is of very great importance in the natural control of the brown-tail moth. Especially in the southern part of the infested area has the parasite proved remarkably effective, despite the fact that it is always the loser when in competition with *Apanteles lacteicolor* or *Meteorus versicolor*. In dissections of thousands of hibernating brown-tail moth caterpillars from all sections of New England it has been common to find from 20 to 30 per cent parasitism by Zygobothria.

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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 1089

Washington, D. C. ▼ September 22, 1922

REINDEER IN ALASKA

By

SEYMOUR HADWEN, Chief Veterinarian and Parasitologist, and LAWRENCE J. PALMER, In Charge of Grazing Investigations, Bureau of Biological Survey.

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1922

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INTRODUCTORY.

Reindeer grazing is an industry of the arctic and subarctic regions. In northern Norway, Sweden, Finland, Russia, and Siberia it dates far back in history and is of considerable economic importance.[1, 2]

[1] Laufer, Berthold, The reindeer and its domestication: Mem. Amer. Anthr. Ass'n., vol. 4, no. 2, pp. 91–147, April–June, 1917.

[2] Hatt, Gudmund, Notes on reindeer nomadism: Mem. Amer. Anthr. Ass'n., vol. 6, no. 2, pp. 75–133, April–June, 1919.

NOTE.—This bulletin presents the results of the first detailed studies of reindeer grazing, range and herd management, forage plants, and of diseases and parasites, with methods for their control. For distribution to those interested in improving the herds and developing the reindeer industry as one of the major resources of Alaska.

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Attempts were begun about 30 years ago to establish reindeer in the Territory of Alaska, the climate and vegetation of a large part of which are closely similar to those of regions occupied by reindeer in Old World countries. In 1891, 10 animals were brought in from eastern Siberia, and in 1892, 171 more, and these, with others introduced from the same source during subsequent years up to 1902, brought the total importations to 1,280.[3, 4] This most admirable project was carried through by the U. S. Bureau of Education on the initiative of Sheldon Jackson in order to provide a means of livelihood for the Eskimos in Alaska, whose former hunting resources were rapidly decreasing. The original, or "mother," herd was established at Teller, on Seward Peninsula.

Conditions in Alaska proved so congenial to the reindeer that from the comparatively insignificant breeding stock imported the increase has been extraordinarily rapid. At the present time, a little more than 30 years after the first importation of 10 animals, without having complete accurate counts, the number of living reindeer in Alaska is variously estimated at from 130,000 to 250,000, with the actual number perhaps approximately 200,000. In addition, it is estimated that about 100,000 have been killed for food and clothing. Begun as an experiment, reindeer grazing in Alaska has amply proved its practicability and demonstrated its importance as one of the great future industries of the Territory.

All of the original importations of reindeer were for the benefit of the Eskimos. In order to teach the natives the proper methods of caring for the herds, the Bureau of Education brought Laplander herders from northern Norway. A system of apprenticeship for Eskimos was established, through which, as they became practiced in herding, they would become individual owners of reindeer, under a restriction forbidding the sale of does. The Laplanders also were granted a certain part of the increase as their exclusive property in order to maintain their services and interest.

For a long period no other white men owned any reindeer, but gradually the Laplanders have sold parts of their holdings, until at the present time one-fourth or more of all the reindeer in Alaska are under white ownership. One company at Nome is reputed to own herds totaling more than 25,000 animals. Through this white ownership definite efforts have been made during the last few years to place the industry on a commercial basis. Several small refrigerating plants have been established on the coast, and shipments of carcasses

[3] Jackson, Sheldon, Introduction of domesticated reindeer into Alaska: 1st to 16th Ann. Repts. of General Agent of Education in Alaska to Commissioner of Education, U. S. Dept. Int., 1890–1906 (1891–1908).

[4] Grosvenor, Gilbert H., Reindeer in Alaska: Nat. Geogr. Mag., vol. 14, no. 4, pp. 128–149, April, 1903.

have been made to Seattle and distributed to large cities in various parts of the United States, where the meat has met with favor and sold at good prices.

Previous to 1920 the reindeer industry in Alaska had been handled under the crude methods of the original herders and without the benefit of any definite scientific investigation or oversight. It had become increasingly plain to the white owners that troubles were developing among the herds which called for investigation and remedy such as is afforded other branches of the modern live-stock industry. As a result, in July, 1920, under authorization of an appropriation by Congress, the Biological Survey established a reindeer experiment station at Unalakleet, on the shore of Bering Sea, 60 miles north of the port of St. Michael, and provided ample equipment for laboratory and other investigational purposes. The staff of experts in charge of the work undertaken were Dr. Seymour Hadwen, chief veterinarian and parasitologist, with his assistant, Dr. George F. Root; and Lawrence J. Palmer, in charge of grazing investigations, assisted by Herbert W. Johnston.

The research staff was instructed to make a close study of the parasites and diseases of reindeer and of methods of combating them; and also to study grazing conditions, forage plants, and herd management over as wide an area as practicable. Another experienced field man, Donald H. Stevenson, as reservation warden of the Aleutian Islands Bird Reservation, was given headquarters at Unalaska and instructed to make a careful reconnaissance of the many islands in that group to determine their availability for reindeer grazing and fur farming. In addition, O. J. Murie, an experienced field naturalist, was stationed in the interior, with headquarters at Fairbanks, to study the caribou herds of that region, which for many years have been of the utmost importance as a source of meat supply to the prospectors and miners over a vast territory remote from ordinary supply points. The conservation of these native caribou herds is a matter calling for serious attention, and the information resulting from this investigation will be invaluable for use to that end.

An additional reason for the caribou work is to locate the most readily available source of supply of the largest caribou bulls to be used to interbreed with reindeer and thus grade up the size and vigor of the latter. The carcasses of reindeer shipped from Alaska have an average weight of about 150 pounds. Large woodland caribou are much heavier and many of the bulls are reported to weigh well above 300 pounds dressed. I am convinced that by the use of these bulls, and with proper methods of selection exercised among the breeding stock of the herds, the weight of reindeer carcasses can be practically doubled within a few years.

One of the most gratifying results of the work undertaken in 1920 has been the appreciation and interest shown by all those in the reindeer business, both natives and white men, and the open-minded way in which a number of herd owners are already putting in effect the improved methods suggested. It is perhaps even more gratifying to be able to say that communications are being received, stating the benefits that have already become evident from the change in management. This receptive attitude of the herd owners indicates that all that is necessary for the general and rapid improvement of the industry is to continue to provide the necessary skilled leadership.

The reconnaissances already made indicate that the Territory has available grazing sufficient to carry between 3,000,000 and 4,000,000 reindeer. The annual surplus from that number would yield a meat product each year worth more than the precious metals mined in the Territory and second only to the fisheries as a permanent income-producing asset.

I wish to take this opportunity of expressing my appreciation of the competent and energetic manner in which instructions given in this work have been carried out by the staff. Doctor Hadwen and Mr. Palmer, after 15 months of field work, submit herewith a preliminary report on the results of their investigations, which it is believed will be of substantial and practical value in the development of the reindeer industry.

I desire also to acknowledge with appreciation the valuable assistance rendered the Biological Survey in the conduct of this work. In Alaska the Bureau of Education and its field representatives have been very helpful, allowing the use of one of their buildings at Unalakleet as the laboratory and living quarters of our staff (Pl. I, Fig. 1); the Lomen Co. and other white owners have cooperated whenever occasion arose; and the Eskimos were everywhere hospitable and eagerly helpful. For assistance in laboratory studies of material the Bureau of Entomology and the Bureau of Animal Industry have rendered every assistance. Help in identifying plants has been given by G. K. Merrill, of Rockland, Me.; R. S. Williams, of the New York Botanical Garden; Paul C. Standley, of the United States National Museum; and Miss Flora Patterson, of the Bureau of Plant Industry.

E. W. Nelson,
Chief of Bureau.

B20467

FIG. 1.—REINDEER EXPERIMENT STATION AT UNALAKLEET, 1921.

The wing at the left served for laboratory purposes, and the remainder of the house was used by the staff for living quarters.

B20469

FIG. 2.—MOUTH OF UNALAKLEET RIVER, NEAR REINDEER STATION.

Hauling winter supplies from boat to store by dog team, October 20, 1920. The schooner *Hazel*, on the right, was purchased by the Biological Survey in 1921 for the use of the staff in its field work.

UNALAKLEET NATIVE REINDEER HERD ROUNDED UP ON BEACH AT MARKING TIME, JUNE 27, 1921.

BIOLOGY OF REINDEER.

DESCRIPTION.

The typical reindeer of Alaska (*Rangifer tarandus*) (Pl. II) is colored approximately as follows: The neck and shoulders are a grayish white, becoming darker on the back, and shading into the much darker sides of the abdomen and hind quarters; the legs are dark to almost black; around the root of the tail there is a whitish area that descends between the legs; the head is dark, except for the muzzle; and the mane, which becomes long in winter, is almost white. In viewing a herd from a little distance, the various colors unite to give the appearance of soft browns and grays with a tinge of yellow. In conformation the reindeer is symmetrical, and gives the impression of blockiness, as in a well-bred beef animal. The average full-grown reindeer stands about 13 to 13½ hands high, and measures about 7 feet from nose to tip of tail.

As compared with the caribou (*Rangifer stonei* and related forms), the general color aspect is similar; but the caribou on the whole is lighter colored, having a white belly and less black on the legs. The caribou is much longer of leg and more ungainly in appearance. Its nose is inclined to the Roman type, and the underlip is short and drawn up, whereas the reindeer is frequently dishfaced, and the underlip is not nearly so trim. The ears of the caribou are a trifle larger.

Reindeer and caribou have the distinction of being the only members of the deer family in which both sexes have horns. These secondary sexual characters are nearly as large in the female as in the male, and it would seem possible that her powers of prepotency may be greater than in the females of other deer. In the course of the investigations in Alaska, a doe was rarely seen which did not have a fawn colored and shaped like herself. As regards color and conformation, the female seems to impress her characters strongly on her offspring (Pl. III, Figs. 1 and 2). Under present conditions where the sire is unknown it is difficult to generalize, but to a geneticist reindeer should be of special interest, since there has been so little interference by man in its breeding, with the exception of the preservation of the white animals.

White and spotted reindeer (Pl. IV, Fig. 1) are common in Alaskan herds. The spotted animals do not seem physically deficient, but the white animals are inferior to those of normal color. They are generally smaller in stature and seldom look robust. Their horns (Pl.

V, Fig. 1) are pink and usually ill shaped, having round blunt extremities, and lack of pigmentation in the horns predisposes the animal to sun scald, and the horns therefore are usually scabby. As opposed to this, a healthy normal reindeer has large horns with sharp points.

None of the white deer were noted to be true albinos, but many were "wall-eyed," i. e., with the iris containing dark pigment, although the sclera are pink and white (Pl. IV, Fig. 2). The white animals react to light, and appear to have some difficulty in seeing on a clear day. Their eyes are running and are kept closed as much as possible.

Both Lapps and Eskimos have noticed what they call the sleeping propensity of white animals, and state that it is possible to approach and capture them when they are lying down. For this reason it is said that bears and other predatory animals frequently catch them. One white fawn (Pl. V, Fig. 2) was noticed lying in the middle of a corral apparently oblivious to all the noise and confusion that was going on at the time. It was possible to walk up to it, apparently without its hearing or being aware of one's presence, and when touched gently it would partly raise its head and then go to sleep again. When it finally became aware that it was being touched by a man, it got up and made off in a great hurry. This observation was repeated later, so that it seems established that white animals are deficient in hearing and scent as well as vision.

These inferior animals have been allowed to breed and increase because there has been absolutely no attempt to cull and grade up the animals in the herds in Alaska and also because the natives are fond of spotted or white clothing and keep the animals to produce skins. The only argument heard in defense of the white reindeer comes from the Lapps, who state that a few white animals are of value in a herd because they can be seen at great distances in summer and therefore help in the herding.

DISPOSITION.

The question is often asked, "What domestic animals do reindeer most resemble in habits and disposition?" It may be said that they have some of the characteristics of sheep, cattle, and horses. They flock together like sheep, but graze more like cattle; and in intelligence and activity they more nearly resemble the horse. They are much more intelligent than cattle, but not so intelligent as the horse.

Many people think that, having such a spread of antlers, reindeer must be dangerous. This is very far from being the case; the reindeer are gentle, but like other domestic animals the bucks are vicious during the rutting season. At other times of the year it is perfectly safe to walk about among a herd packed into a corral, and the ani-

mals will invariably give way on the approach of a man. When disturbed or frightened they run together and then face the common danger. Thus it is possible to round up a herd in the open and with the lasso catch any desired animal. Reindeer are very active for short distances and display as much action and speed as an ordinary driving horse.

Reindeer may become quite friendly and trustful, and remember their master for a long time. As they are seldom used for work except when snow is on the ground, they are handled directly only for a short period each year, but once broken they do not seem to forget. When they are being handled it is wise to watch out for their horns and to avoid being struck by their fore feet, but even when being roped by men on foot, as they always are, injuries to the ropers from the animals are uncommon and are usually due to carelessness. Finally, it can be said that reindeer are more easily handled by men on foot than are cattle.

TEETH.

At birth the reindeer fawns have 8 temporary incisor teeth and 12 molars fully up with 4 more molars just appearing through the gums. At 10 to 12 months the temporary incisor teeth are shed and replaced by permanent incisors. The temporary incisors are smaller and somewhat smoother and narrower than the permanent ones. At the end of the first year 4 more molars appear, making a total of 20. During the second year 4 additional molars appear, and toward the close of the season the two anterior molars are shed and replaced. The total dentition of a three-year-old animal consists of 8 incisors and 24 molars, a total of 32 teeth.

Wearing down of incisors.—At 2 years of age the two central incisors show signs of wear. At 3 years all the incisors are worn. At 4 years the teeth begin to separate a little, and year by year the separation and wear goes on until at 14 to 15 years it will be found that the incisor teeth are completely worn down to the gums and show only as little round stumps set far apart. When the mouth reaches this condition it plainly indicates that the usefulness of the animal is past.

SHEDDING HORNS.

Fawns.—The fawns shed their horns about April 15, one year after birth. The new growth starts almost at once and 10 days later there may be a quarter of an inch of velvet. The growth of horn is almost complete by July 1, or when the animal is about 15 months old. This applies to both male and female fawns.

Adult does.—The shedding of the horns of the adult does (2 years of age or over) occurs a few days after dropping the fawn. The

period of shedding for the female herd as a whole covers a comparatively long period, since the fawning season extends from April 10 to the end of the first week in May. On April 20 some hornless does may be seen, but these are few in number. The shedding increases day by day until the peak is reached early in May, the last horns falling off about the 20th of the month. Occasionally does may give birth to fawns before or after the ordinary season, and in this event she casts her horns after the fawn is born. In one case a doe that dropped her fawn about August 28 was noted with one horn shed and the other clear of velvet on September 19.

Bucks.—Reindeer bucks $2\frac{3}{4}$ years of age and over drop their horns after the rutting season in November. The coming 2-year-old bucks shed their horns shortly prior to the time the females drop theirs. About the middle of November, in one of the herds at Unalakleet, there were observed many hornless bucks. Early in January, in two large herds which were counted, no bucks over $2\frac{3}{4}$ years old were in possession of horns. In contrast to this, none of the coming 2-year-old bucks had shed their horns at that time. Apart from lack of horns, it is easy to pick out the bucks which have been rutting, as they are gaunt and tucked up in the flanks, whereas those under 2 years of age are usually in good condition. As the bucks cast their horns much earlier than the fawns or does, the new horns are far advanced in growth before those of the other members of the herd, and by the middle of April they may attain a length of 18 inches.

Steers.—Castration has a remarkable effect on the horns, these secondary sexual characters being materially affected by any form of injury to the reproductive organs. It has been a common practice in Alaska to castrate the bucks that have been in service one or two years. Many are castrated in August, just before the beginning of the rutting season, i. e., after the velvet has peeled or "set" on the horns, and within the next two to three weeks the horns fall off (Pl. VI, Fig. 1). When the horns are in the velvet and are growing at the time of castration the effects are quite different, in that both the horns and velvet remain on. Properly castrated steers retain the velvet until the horns fall off in the spring. If the operation has been only partially successful, as is often the case with the Lapp method, the effect is again different. The shock of the operation may cause the horns to fall off, but the following season, when the new horns appear, these partially sterilized animals show some signs of rutting, the velvet is partly peeled off the horns, and other evidences of sexual activity are shown. When an animal has been properly castrated (the glands entirely removed) it is docile and the velvet remains intact on the horns (Pl. VI, Fig. 2).

B22745

FIG. 1.—SPOTTED REINDEER DOE AND FAWN.

The resemblance between the two is marked. Females have horns, like the males. They appear to be very prepotent and impress their characters strongly on their offspring.

B22707

FIG. 2.—LIGHT BLUE-ROAN DOE AND PROGENY.

Resemblance in color and form is noticeable.

B20527

FIG. 1.—REINDEER IN THE VELVET.

The spotted doe on the right is a well-shaped animal. While not so desirable as animals uniformly colored, spotted reindeer are nearly normal in all but color, thus differing from the pure white ones, which are obviously defective. On the left is an old female which has outlived her usefulness. The unshed winter coat is a mark of diminished vitality and indicates that the animal should have been killed for meat the previous fall. (Photograph by Lomen.)

FIG. 2.—WHITE REINDEER.

The characteristic dark pupil indicates that white reindeer are not true albinos. Lapp herders value a white animal here and there as an aid in locating the herd at a distance.

B22690

FIG. 1.—WHITE DOE, WITH CHARACTERISTIC POORLY DEVELOPED AND ROUND-ENDED HORNS.

Animals of this type should be eliminated, as they produce undersized fawns and thus lower the quality of the herds.

FIG. 2.—WHITE FAWN.

White reindeer are deficient in many respects. Their eyes are weak, and they lie and sleep much of the time. As a result they are easily approached and become the prey of wild animals.

B22739

FIG. 1.—HORNLESS, PARTLY WHITE, REINDEER.

This animal, in center, had been castrated about three weeks before. When the operation is performed after the velvet has been lost, the horns drop a few weeks later. The burlap covering the corral wall prevents the animals from seeing outside and thus makes their control easier.

B22629

FIG. 2.—SLED DEER, VELVET INTACT.

Photographed in January. This animal, properly castrated, had not rubbed the velvet from the horns as do normal bucks.

FIG. 3.—REINDEER SHEDDING THEIR COATS.

Photographed on July 25, 1921, on St. Lawrence Island. The bucks shed first, in spring, then the steers and young stock, the does a little later, and, last of all, the sick and old animals. On the left is an old doe shedding her winter coat.

GROWTH OF HORNS.

The growth of the horns is so rapid that at times the animals show signs of some irritation or perhaps even of pain. It has been observed that they are constantly touching them with the hind fetlocks, but they do this very gently and with a sort of rubbing motion. Evidently the horns at this stage are so tender that care is taken not to injure them. Once the growth is complete and the velvet has become avascular, the animal's attitude changes and the horns become weapons of offense and defense.

SHEDDING THE VELVET.

As the bucks shed their horns the earlier, it is natural to expect that they would peel off the velvet before the other sex. The earliest signs of peeling noted were on July 31, but it was not until August 15 that the horns were becoming clean and polished; and even then, in a good many cases, there were still strips of velvet hanging to them. The horns are entirely clean and the rutting season has begun by approximately August 25. Most of the does shed the velvet by August 20, although strips of it may still be adhering to the horns of many up to September 10 and even later. The fawns shed a little later than the does. Properly castrated steers should have the velvet intact at this time (Pl. VI, Fig. 2).

SHEDDING HAIR.

The bucks are the first to shed the hair in spring, and by the middle of June most of them will be in good coat. Females, in some districts at any rate, are a week or two later. Yearlings correspond more to the does in time of shedding. It has been noticed that old or diseased animals are slower in shedding than those that are healthy, and ragged-coated does have been seen up to the first days of August. As the hair is closely related to the horns histologically, it will be seen that the shedding of hair links up closely with the growth of the horns (Pl. VI, Fig. 3).

ALASKAN AND NORWEGIAN REINDEER COMPARED.

An importation of Norwegian reindeer into the United States in March, 1922, afforded opportunity of making a comparison between them and the Alaskan species. The reindeer in the Norwegian shipment compare very unfavorably with the ordinary run of reindeer in Alaska, and, in comparison with the best Alaskan animals, so far as concerns size and general appearance, they can be rated as very inferior. Full-grown Alaskan reindeer measure 13 hands and over. The largest Norwegian buck and doe measured only about an inch over 10 hands. The largest Norwegian buck weighed 175 pounds and the largest doe 148 pounds.

The Norwegian animals had just landed after a long, rough voyage, but even when fed they would fall short of the average weight of Alaskan reindeer, which for steers average 150 pounds dressed. The ages of the Norwegian animals ran between 3 and 4 years.

The Norway reindeer differs a little from the Alaskan animal in being lighter colored. At first sight more white was noticeable around the feet and legs, and in some instances the belly was almost white. As a rule, the sides of the belly in Alaskan reindeer are very dark and in some cases almost black. In other respects the marks are almost identical.

REINDEER AS RANGE STOCK.

OWNERSHIP OF REINDEER.

The ownership of the reindeer herds in Alaska now falls largely into three classes: Eskimos, white men married to Eskimo women, and other white men, including Lapps. Formerly herds were also owned by the Government and by the various missions located in Alaska, but these owners have practically dropped out, as also have many of the Lapps. While no complete information as to exact numbers of reindeer or exact ownership is available, it is generally considered that, on the basis of an estimated total of 130,000 animals, the whites, including Lapps, now own about 40,000 to 45,000, and the Eskimos the remainder, or some 85,000 to 90,000. In 1917, the Bureau of Education reported the Eskimo ownership to be distributed among 1,568 natives.

The ownership of reindeer among the natives is not uniform. There are numerous small owners, each with a few head, often only 2 or 3, and a few Eskimos are large owners, with several hundred to a thousand animals. Among the whites, aside from the Lapps, and those married to native women, who for these purposes are classed as natives, ownership is as yet limited, being largely confined to the relatively few who have been able to buy the herds that had been acquired by the Lapps and the missions.

Up to within a few years, the Alaska reindeer industry had been largely a native enterprise and development has been entirely under the supervision of the Bureau of Education. The Eskimos were taught herding and given ownership in reindeer through a system of progressive apprenticeship under instruction of the Lapps brought over from northern Norway for the purpose. The reindeer were originally imported for the Eskimo, and the policy of the Government was to limit ownership as much as possible to the natives, but an exception was made in the case of the Lapp herders and of missions. Largely through recent purchases of herds from

these latter owners, white men have been able to become owners and to enter the industry.

In the beginning it was no doubt necessary to exclude the white man from ownership in order to insure protection for the native, but since the latter is now well started in the reindeer industry and since there is sufficient room in the grazing areas for both the natives and white men, there appears to be no longer any reason why the white man should be excluded. As a matter of fact, white ownership of herds is now needed to assure the desirable economic development of the industry. This is particularly so, since at this stage there is great need for more capital and initiative to establish the means of transportation and marketing necessary to put the industry on a commercial basis.

INCREASE OF HERDS.

There are in Alaska about 100 herds of reindeer, widely distributed from the north shore of the Alaska Peninsula to Point Barrow and from the shore of Bering Sea eastward into the interior above Ruby on the Yukon and to the vicinity of Flat on the upper Kuskokwim River. Plans are in progress to establish a herd in Broad Pass, on the Alaska Railroad, during 1922.

The growth of the reindeer industry in Alaska in the period of 20 years from 1902 to 1921 shows an annual net increase of about 27 per cent, or, taking into consideration the estimated number of stock slaughtered during that period, an annual gross increase of about 33⅓ per cent. This rapid increase from the small beginning in 1902 indicates a promising future. Swedish figures for reindeer place the herd profit, or net increase, in normal years at 25 per cent.[5] The average fawn crop in Alaska runs between 50 and 60 per cent, although the average prolificacy of reindeer is indicated as about 70 per cent, with the highest percentage as 85 to 90.

As a general rule, in the fawns the relative numbers of the two sexes are remarkably close, practically 50 per cent of each. These figures are of interest as indicating the possibilities in reindeer grazing. Under present management there is a wide margin of loss, but under improved methods this can be materially reduced. While the recorded losses in the herds are incomplete, in adult reindeer the annual average is about 6.5 per cent and in fawns about 15 per cent. Losses in adults are largely attributed to diseases and parasites, injury in handling, predatory animals (including dogs), and straying; losses in fawns are attributed to desertion by mothers, stillbirths, predatory animals, and parasitism.

[5] Guinchard, J., Historical and statistical handbook: Swedish Government, Industries, 2d ed., Stockholm, 1914.

extent by thorough cleanliness. In cold weather it is out of the question to wash carcasses, and therefore the greatest care must be used to keep them free from dirt. The man who does the butchering should handle nothing but the carcass. Where proper slaughterhouses are available and animals are butchered before severe cold weather, portions of the carcass may be washed if running water and a brush are used. Cloths and a bucket of water should never be used, on account of the danger of spreading molds from one carcass to another. Special care must be taken to avoid contaminating the interior of the carcass with contents of the stomach, which are apt to regurgitate up the gullet, since it is probable that the food contains the spores of molds. The gullet should be tied as a precautionary measure.

A most important point in the prevention of molds is to keep the frozen carcasses at a uniform temperature, to give the molds no chance to grow. With fluctuating temperatures in the cold-storage room, molds gain rapid headway and the meat soon spoils. Furthermore, alternate thawing and freezing injures the cells and thereby lowers the quality of the meat.

Hides should be left on the carcasses intended for shipment out of Alaska. Skinned carcasses are much more likely to mold and also to lose their color and to shrink more in weight. When the hide is left on, the brisket is frequently left closed and the pelvis need not be split. If the brisket is not split the carcasses pack together much better. One point which must be kept in mind in this connection, however, is that the animal heat does not leave the body as quickly when the carcass is not skinned or completely opened. Reindeer hair is an excellent nonconductor and prevents the heat from leaving the body very rapidly. Hence, cold storage should be available to cool the animals as soon as possible after slaughter in summer. Cold-storage rooms should be disinfected at intervals. Information received from the meat inspection division of the Bureau of Animal Industry indicates that strong hot brine applied to the walls of a storage room is very efficacious in keeping down molds.

Bucks should never be killed for food, as the meat has an objectionable odor and taste and spoils easily. Some bucks have been killed for marketing, but the practice is an indication of carelessness and bad management, especially where the killing is done late in the year, or after the rutting season has begun. If bucks are to be slaughtered they should be castrated just prior to this period, or about the middle of August. The animals will then fatten and be in condition to kill later in the season and will not have the strong odor and taste.

Fawns are frequently killed in great numbers at marking time, in some cases owing to injuries received in the corral, and at other times to provide skins for making parkas, sleeping bags, and other articles. The meat of the fawn is of good quality and is used locally. It has been recommended that old does be slaughtered after they have passed the breeding age. If fat, these animals produce excellent meat, and while they are naturally a little lighter than the steers, they can be used to supply the local demand.

Time for slaughtering.—It is frequently stated in Alaska that reindeer are fit to kill in the latter part of July and early in August. Even though the animals look fat at that time, however (Pl. VII, Fig. 1), the meat is soft and watery and the back fat, being in a growing condition, is vascular and red. There is no comparison between this meat and that which is killed later in fall, at which time the fat is white and firm.

The best time for slaughtering is in October and November. Steers are at their prime in October, although the meat is in almost equally good condition during September and November. In September, however, rutting is in progress and the herds should not be disturbed. When December is reached the condition of the animals begins to deteriorate, and at that season the parasitic warble grubs have developed to a considerable size, so that from December onward the meat becomes of less and less value.

All domestic animals store up a reserve supply of fat before the advent of winter. As a rule this is laid on evenly, and generally a large part of it will be found on the omentum, or leaf, in the abdominal cavity. In the case of reindeer, the leaf fat is in small quantity and the winter reserve is laid on the back in two masses; hence it is called back fat. This is relished by the natives perhaps more than any other part of the reindeer, and by the whites it is often cut into strips and used like bacon. It does not have the strong flavor of mutton tallow and is a valued food in the North.

In the accompanying illustration (Pl. VII, Fig. 2) it will be seen that the fat lies on either side of the backbone. It starts just level with the root of the tail, with the greatest thickness 2 to 3 inches over the rump, and tapers off like a wedge in front of the kidneys. In reindeer the thickness of this layer is a true indication of the fatness of the animal, for, as it is laid on last, it means that all other parts of the animal are fully stocked with fat. Consequently, the time for slaughtering is when the back fat is at its thickest.

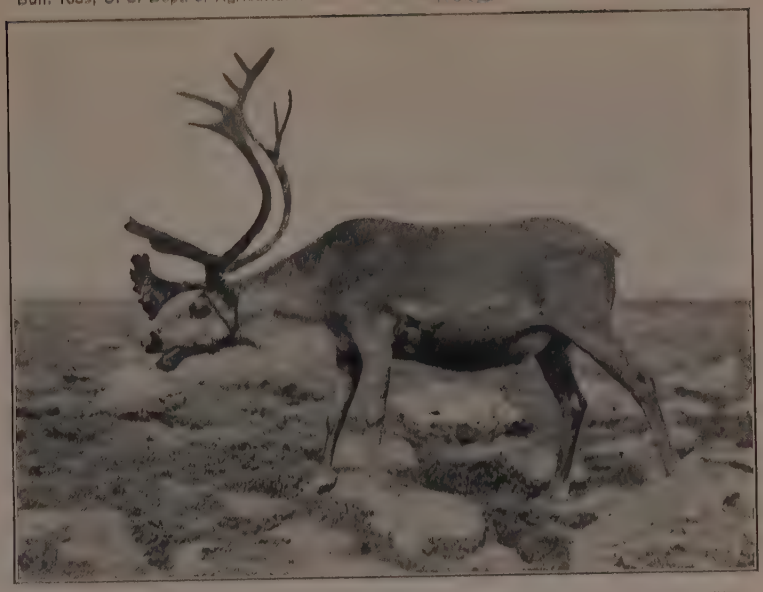
Cutting up a carcass.—The Lapps employ what is considered a very good method of cutting up a carcass. The head is severed at the first joint (atlas). The neck piece includes the first two ribs.

The brisket is removed by cutting through the ribs along the cartilages, and the abdominal muscles go with it. The cut follows the flanks up to the stifle joint. The backbone is removed entire, the heads of the ribs being disjointed at their points of attachment. The front leg is cut off at the elbow joint and the hind leg at the stifle. This leaves two sides with the shoulders and hams attached. Later the sides are cut into three pieces, leaving the hindquarters, ribs, and shoulders. The reason for cutting the legs so high is to save the sinews. The back sinew, which is the most valuable in the body, is removed from the long muscles of the back and the back fat is taken off. The saving of the sinews is important, since they are valuable for sewing purposes, the market value of a set from one animal being, in 1921, about $1.50. This method of cutting up a carcass is good when at a reindeer camp or out in the hills. It can be done on the ground in a cleanly manner and a knife is the only instrument required.

Utilizing natural cold storage.—A deep layer of permanently frozen earth and underground ice along the coast of Alaska offers natural cold-storage facilities so readily available in a large part of the Territory that it is surprising so little use has been made of it. In a few instances small storage rooms have been made by hewing out chambers in this frozen layer, but so far as can be ascertained the only large storage room in use is one made by the Bureau of Education at Point Barrow. In many places on the Seward Peninsula and elsewhere the frozen layer is composed of crystalline ice free from impurities. Its depth has not been ascertained by the authors, but shafts have been sunk in it to a depth of 20 or 30 feet. Covering the ice usually is a layer of soil one or more feet in thickness. In some places there are frozen beds on hill slopes, so that the storage rooms constructed in them could be entered on a level through a tunnel and thus obviate any danger of flooding from surface water or melting.

In such a bed of ice the problem of keeping meat should be a simple matter. In another paragraph it has been recommended that reindeer be slaughtered after the cold weather has set in. Frozen carcasses could then be packed into one storage room at a time, which could then be carefully sealed. Double doors and sawdust will be necessary to insulate each room thoroughly. In this way it can be confidently predicted that meat can be kept almost indefinitely and at a trifling cost.

Marketing and transportation.—The market in Alaska for reindeer meat is as yet largely local and therefore limited by reason of the small and scattered population and the generally poor transportation facilities. Of the total native and white population of



122671

FIG. 1.—STEER IN SUMMER CONDITION (JULY).

At this time of the year the animals are fat, but the meat is watery and the fat reddish. The abdomen is large because of the watery vegetation in the summer food.

120752

FIG. 2.—REINDEER HINDQUARTER IN NOVEMBER.

The layer of back fat lying between the muscles of the back and the skin in this animal was 2 inches thick. This layer is like tallow and is put on in fall as a reserve food supply and absorbed during the winter.

B20514

FIG. 1.—DRESSING REINDEER FOR MARKET.

Carcasses being prepared at Nome by a white butcher, assisted by Eskimos. (Photograph by Lomen.)

B20526

FIG. 2.—REINDEER DRESSED FOR SHIPMENT.

On lighter alongside slip at Nome, ready to go on board. Reindeer meat is shipped every year to the United States, mainly in fall. (Photograph by Lomen.)

the Territory (54,899) only about 25,000 live within the area to which reindeer grazing applies, and only about 15,000 within the immediate reindeer districts now holding herds. The Eskimo and Indian population alone is about 25,000.

The reindeer of the Eskimos furnish meat and skins for the most part to the owners, but a portion of the surplus is sold in local mining camps or in white settlements. The Lapps and other whites likewise have a similar sale for a limited portion of their surplus, but for the most part the Lapp has depended upon a market for his reindeer in the sale of breeding stock to other whites.

In marketing locally the reindeer are usually driven to the town or camp where sale is to be made and there slaughtered. Usually long drives are necessary, and they are generally undertaken in the early part or middle of the winter. The white man is largely a beginner in the industry and is looking toward its larger development and to an outside market, the opening up of which has just begun (Pl. VIII, Fig. 2).

Transportation in northern Alaska during the winter is almost entirely by dog team (Pl. I, Fig. 2) and in summer by boat. Horses are used to some extent in the interior. The new railroad between Seward and Fairbanks should prove a vastly important factor in establishing the reindeer industry in the interior. Aside from the railroad, transportation between the United States and northern Alaska is by boat and limited to the summer and fall months. During the winter most of Bering Sea is covered with pack ice, so that navigation is impossible.

Development of regular markets and better means of transportation and marketing are particularly necessary at this time to place the reindeer industry on a proper basis, and the establishment of a definite cash market for his surplus stock will greatly encourage the Eskimo as well as the white man to adopt improved methods of management.

BY-PRODUCTS.

Up to the present time by-products from reindeer have been to a large extent neglected. Some hides, which are used in the manufacture of leather goods, have been exported, and in a few instances the horns have been shipped to be used for making knife handles and similar articles. The hair is of value for stuffing life preservers and filling horse collars, but has been little used for these purposes. In the slaughterhouses the blood and viscera have been thrown away, whereas they might be used for making meal for dog food. There

is much room for development in the use of these by-products. Under modern packing-house methods, more use will undoubtedly be made of many of the parts now being discarded.

TANNING.

The native methods of tanning hides in Alaska are primitive and there is great need for improvement. Since reindeer skins are required for the making of clothing and other uses in the Territory, it seems highly desirable that the Government provide an expert to instruct the Eskimos in tanning.

The skins which come from Siberia have a much superior tan, generally speaking, than the Alaskan article; consequently large numbers of hides are imported annually from Siberia by the traders for sale among both natives and whites. In fact, this trade is so large that it is a considerable item in the list of Alaskan imports. In addition to the tanned skins, made-up reindeer-skin parkas and other articles of clothing are brought over each season. This trade could be saved to a great extent for the natives of Alaska if they knew better methods of tanning. With the rapid increase of the reindeer herds it is time to prepare an outlet for all reindeer by-products.

REINDEER MILK.

Milk from reindeer is often used in making cheese, butter, etc., in other countries where the animals are raised. While the milk may be valuable as a food in Alaska, the natives and whites have made no extensive use of it as yet, and at the present time milking is not done in any of the herds. The reasons for this are not far to seek. In the first place there are no inclosures or other means available for holding the reindeer for the purpose of milking. Secondly, milking strains have not been developed.

When the Lapps first came to Alaska they practiced milking to a limited extent. They state that when the herds were small it was a comparatively simple matter. The procedure followed was to drive the herd to some convenient place each morning, where the animals to be milked were caught one by one with the lasso. Each one yielded about a cupful of milk. It can readily be seen that this practice was neither economical nor good for the herd, and it was soon abandoned.

If the best milkers were picked and the fawns separated from them, and in addition if the animals were kept in good fenced pastures and properly taken care of, the yield of milk from reindeer could be greatly increased.

GRAZING AND RANGE MANAGEMENT.[8]

AVAILABLE GRAZING AREA.

Lands in Alaska available for reindeer grazing fall into two divisions—the coastal areas, immediately bordering the Arctic Ocean and Bering Sea, including the islands; and the interior areas, lying between those along the coast and the Canadian boundary. Along the coast summer grazing is mainly near the sea, where the reindeer can obtain salt, and on wind-swept areas where they are protected from insects. In the interior, summer grazing is on the windy mountain tops.

Most of the present grazing is on the coast ranges, which are most convenient of access and have better transportation facilities; the interior ranges, not so accessible, still remain largely untouched.

On the coast ranges, reindeer now graze from Point Barrow on the north to Bristol Bay on the south and also on St. Lawrence and Nunivak Islands, the Pribilofs, and Umnak and Atka in the Aleutian Chain. The main grazing, however, is about four chief centers, namely, the Kotzebue Sound country, Seward Peninsula, about Norton Sound, and in the Kuskokwim River basin.

On the far interior range (Pl. IX, Fig. 1), reindeer grazing to a small extent has been established at only three points, namely, on the upper Kobuk River, above Ruby on the Yukon, and on the upper Kuskokwim. While there had not been sufficient range reconnaissance to determine exactly the full range extent and its possible carrying capacity, it is apparent that there is still room for considerable expansion on the coast ranges, especially with the introduction of improved methods of handling the herds; and the far interior ranges present practically a new field which should prove important for the future expansion of the industry.

Expansion into the interior will depend primarily upon the availability and accessibility of suitable range sites. The popular belief that reindeer may be handled wherever caribou are or

[8] Since basically the principles of cattle and sheep grazing are largely applicable to reindeer grazing as well, the following publications dealing with phases of range and stock management are listed for reference:

Jardine, James T., and Mark Anderson, Range management on the national forests: Bull. 790, U. S. Dept. Agr., 1919.

Jardine, James T., and L. C. Hurtt, Increased cattle production on southwestern ranges: Bull. 588, U. S. Dept. Agr., 1917.

Jardine, James T., Improvement and management of native pastures in the West: Separate 678, Yearbook 1915, U. S. Dept. Agr., pp. 299, 310; 1916.

Jardine, James T., The pasturage system for handling range sheep: Forest Service Cir. 178, U. S. Dept. Agr., 1910.

Sampson, Arthur W., Range improvement by deferred and rotation grazing: Bull. 34, U. S. Dept. Agr., 1913.

Sampson, Arthur W., Natural revegetation of range lands based upon growth requirements and life history of the vegetation: Journ. Agr. Research, U. S. Dept. Agr., vol. 3, pp. 93–148, 1914.

Sampson, Arthur W., Plant succession in relation to range management: Bull. 791, U. S. Dept. Agr., 1919.

Jardine, James T., and C. L. Forsling, Range and cattle management in time of drought: Bull. 1031, U. S. Dept. Agr., 1922.

have been is only partially true. Caribou are not herded, but roam at will. By traveling in small bands and covering much territory they thrive on small moss areas and a certain amount of timber vegetation. A reindeer herder would have a hard time attempting to utilize some of these ranges. He might do so in some cases perhaps by adopting the nomadic mode of existence of the Lapps of northern Norway and Sweden. In the large timbered areas of the interior it is unlikely that a reindeer herd could be handled without considerable fencing. Grazing could be carried on successfully, however, wherever there is suitable forage and an area large enough to accommodate a reindeer herd the year round.

An accurate statement of the possible future carrying capacity of Alaska for reindeer grazing can not be given until a complete range reconnaissance has been made. Judging from a very general preliminary survey of the field as a whole, there are probably between 150,000 and 200,000 square miles of open grazing lands available. This area is estimated to be capable of supporting between 3,000,000 and 4,000,000 reindeer. The estimate includes all potential ranges, on the islands, along the coast, and in the interior. Development of some of these ranges for grazing, particularly in the interior, will probably come only with a greater development of transportation facilities, particularly roads. The immediate coastal areas and those along navigable rivers and the Alaska railroad will undoubtedly be developed in the near future (Fig. 1).

RANGE SUITABLE FOR REINDEER.

The suitability of range for reindeer depends principally upon climate and forage and to some extent upon character of site. The natural habitat of the reindeer is in the arctic and subarctic regions, and the animals will undoubtedly do best on ranges falling within these climatic zones. Whether they can be grazed successfully farther south is not definitely known, but is a matter for experimentation. Michigan is now (1922) undertaking the experiment and the results will be awaited with interest.

Reindeer on the range most closely resemble cattle, but band together more like sheep, and like the horse they trample over much range in nervous feeding, but, unlike the horse, they travel against the wind. In winter they paw through the snow with the fore feet to reach lichens and other forage (Pl. X, figs. 1 and 2). During the summer they move about over the range a great deal, and at times cover considerable distances against the wind. In winter they graze more quietly over a comparatively small area, and remain mainly in one general locality. At fawning time the herd divides, the does grouping by themselves and the bucks, steers, and some of the yearlings banding together elsewhere.

B23999

FIG. 1.—INTERIOR RANGE SUITABLE FOR REINDEER.

Vegetation mainly reindeer moss and browse, between 2,500 and 3,000 feet elevation. An unusually heavy growth of reindeer moss, both in the foreground and on the mountain slopes.

B22501

FIG. 2.—WET TUNDRA TYPE OF FORAGE.

Largely sedges and small browse growth, "niggerheads," characteristic of much of the summer range on the coast of Bering Sea. Reindeer fawn in the foreground.

B22589

FIG. 1.—REINDEER ON WINTER RANGE.

Photographed February 21, 1921, at Pikmikalik, between St. Michael and the mouth of the Yukon. The snowfall was light in this region in 1921 and the reindeer are seen grazing practically unhampered by it.

B22821

FIG. 2.—MOSS UNCOVERED BY REINDEER.

The herds paw through the snow with their forefeet to reach the lichens and other vegetation upon which they feed on the winter range.

B22815

FIG. 1.—LICHEN, OR "MOSS," TYPE OF FORAGE.

Characteristic growth on upper slopes of inland winter range back from the coast.

B22810

FIG. 2.—NEAR VIEW OF REINDEER MOSS.

Pile gathered from growth on a good winter range in three or four minutes within a radius of 6 or 8 feet.

FIG. 1.—SUMMER RANGE ALONG THE COAST.

Forage type mainly sedges, browse, mosses, and grasses.

B20747

FIG. 2.—WINTER RANGE BACK FROM THE COAST.

Vegetation mainly lichens, mosses, browse, and sedges.

Reindeer are attached to their accustomed haunts, and when well located on a range will unerringly return to it if moved away. With change in seasons, unless restrained, they instinctively seek their favorite winter, fall, or summer pastures. In the choice of summer pasturages, such reindeer pests as mosquitoes and warble flies play

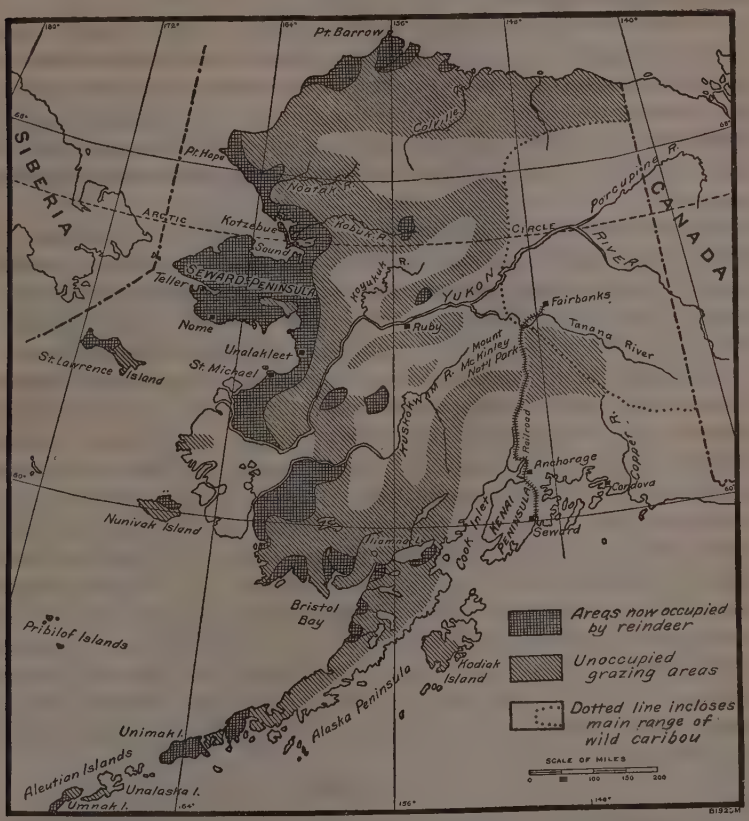


FIG. 1.—Preliminary map of reindeer grazing areas in Alaska, showing areas now partly occupied by herds of reindeer and areas not yet occupied but suitable for reindeer grazing. It should be understood that the grazing areas indicated are approximate only and will be largely modified by more detailed investigations. On the Pribilofs there are two small Government-owned herds, and a small herd is on Atka Island, in the Aleutian Chain, not on the map. The area inclosed by the dotted line shows range reserved for wild caribou.

an important part, causing the reindeer to seek the wind-swept areas adjoining the beach along the coast, and the wind-swept ridges and low mountain tops in the interior.

In the arctic habitat a range must be selected having available for winter grazing an area not subject to periodic crustings of the

snow. Where held too near the coast during the winter season, even within the Arctic Circle, reindeer herds occasionally suffer considerable losses through starvation when winter rains fall on the snow. In such cases the herd must be moved back to protected areas in the interior hills, but heavy losses may occur before the animals can reach favorable ground.

Under ordinary conditions, depth of snow on the winter range along the coast does not constitute a serious factor, since at least a part of the area is generally exposed to the winds and so does not become deeply covered. In the interior, however, particularly on timbered flats and bench land country, there is less drifting, and depth of snow is then a matter to be considered in the selection of winter range.

The area selected for grazing should lend itself to the handling of the herd throughout the year. It should comprise a natural grazing unit, with the spring, summer, and fall, and the winter ranges combined. In a timbered country, reindeer are difficult to herd successfully, and in the absence of fencing this is a factor to be considered.

The value of the different kinds of range forage plants varies greatly with the stage of growth, and probably to some extent with the tastes of the animals. As a rule, reindeer prefer green vegetation and fresh growths and are fond of variety. They feed upon a great number of range plants, but in winter graze especially upon mosses and in summer upon green vegetation (sedges, browse, grasses, and weeds). In spring they seek the earliest green vegetation, and feed on green growth throughout the summer. In fall and winter they feed on dry vegetation of various kinds and on lichens and mosses, but prefer the lichens known as "reindeer moss," which, having made new growth in fall, are fresher and probably more palatable (Pl. XI, Figs. 1 and 2). While the lichens represent principally winter forage, they are also taken to a certain extent during the summer.

FORAGE COVER.

The character of vegetation along the coast is very similar throughout, the relative proportions of the various species and their density varying, however, with exposure and other conditions. The cover comprises a composite type of lichens, mosses, sedges, browse, weeds, and grasses, most of the summer range (Pl. XII, Fig. 1) containing a predominance of sedge and species of browse, and that of the winter a predominance of lichens and browse (Pl. XII, Fig. 2).

As a general rule, the percentage of lichens increases in the vegetative type with the distance from the coast except in valley and basin areas. Very little timber occurs within the coastal areas—none at all over the major portion of Seward Peninsula, practically none

over the belt of summer range immediately adjoining the coast, and only very scattering stands over the neighboring inland areas which are chiefly winter range.

Immediately along the coast occurs the bulk of the forage most suitable for summer grazing, consisting largely of herbaceous and nonmoss growth; and adjoining this belt toward the interior lie the fall and winter ranges, covered largely with lichens. The belt of summer range will run from 7 to 30 miles wide, generally averaging about 10 to 15 miles, and the strip of winter range will equal and exceed this.

The vegetation along the coast is very luxuriant, especially on flats, benches, and lower slopes (Pl. IX, Fig. 2). A hummocky ground of moist to wet soil, called "tundra" or "niggerheads," predominates on the lower elevations, and a dry, generally rocky ground occurs on the upper slopes and the tops of ridges. The vegetation of the tundra areas is very dense, often matted, and is of profuse growth (Pl. XIII, Fig. 1). On the upper slopes and tops of ridges it is less dense and becomes dwarfed. On small areas of sandy soil which occur along the beach or in forested areas along streams, the grasses and weeds frequently attain a height of 3 and 4 feet. In many places the tundra growth of mixed sedges, browse, grasses, weeds, and lichens will form a vegetative mat 10 to 12 inches deep. Thickets of tall willow are often found along stream courses; scattering stands of alder and birch frequently occur on upper slopes or mixed with spruce along the larger river valleys; and a mixture of low brush, as ground birch, ground willow, huckleberry, salmonberry, cranberry, crowberry, and tea, is abundantly scattered throughout the ranges. Grasses and weeds are of only scattering occurrence. Sedges, browse, and lichens form the bulk of the vegetation.

While a general type of vegetative cover occurs over the coast ranges, the physical characteristics of the land and soil vary considerably, thus producing three main classes or types of range, which may be termed generally the dry tundra, the wet tundra, and the rocky areas. In terms of relative carrying capacity the dry tundra type should support a greater number of reindeer per acre than the wet tundra type. While both types will run about equally high in average forage production, the soft or marshy nature of the ground reduces the actual carrying capacity of the wet type because of the greater harm done to the forage plants in being ground into the wet earth by the trampling of grazing animals. On the other hand, the rocky type usually will have a lower carrying capacity than the other two, because of the smaller forage growth.

In the interior areas covered by preliminary reconnaissances, particularly the Tanana-Nenana River country, it was found that ranges best adapted to reindeer grazing lie generally between timberline (approximately 2,700 feet) and the snowline (approximately 6,000 feet). The growth cover on this range includes principally three main types of vegetation, namely, conifers, browse-lichens, and lichens, occurring largely according to zone. Browse and species of lichen predominate and, as compared with the coast range, there is a noticeable absence of grasslike vegetation, especially the sedge or "niggerhead" type (Pl. IX, Fig. 2). Up to between 4,000 and 5,000 feet a dense cover of vegetation occurs, lichens especially appearing in profusion. Between 4,000 and 5,000 feet up to 6,000 feet the rocky nature of the soil supports a cover of lower density. Above 6,000 feet the ground is perpetually covered with snow.

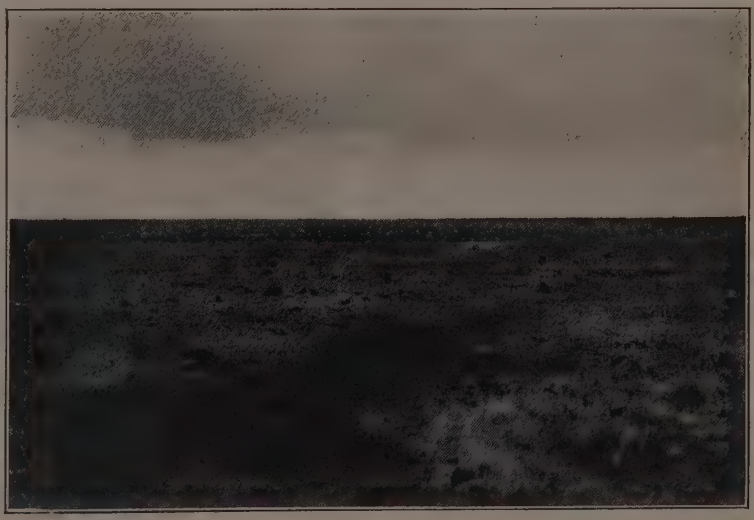
Around the lakes and along streams up to 2,500 to 3,000 feet elevation the principal types of vegetation are conifers with a browse-grass to browse-lichen subtype (Pl. IX, Fig. 1). This type blends into the browse-lichen and browse-grass types which extend up to 3,800 and 4,000 feet. Above 4,000 feet a nearly pure lichen type comes in, continuing up to snowline, at 6,000 feet. Up to 3,000 feet the conifers grow in scattering open patches, while above this elevation they become very small and scattering, and usually 2 to 3 inches in diameter. The browse, of which ground birch is the most abundant species, often occurs in very dense patches, chiefly in comparatively dry, gravelly soil. Willow grows on the more swampy areas and along stream courses. Alder is found in patches above timberline. Of the lichens, species of *Cladonia* are most abundant. On the river bars and the lower benches of the main drainages, grasses and weeds form the principal growths. On lower south exposures, grasses are often the main vegetation.

Forage types.—A summary of the principal forage types occurring on the immediate coast ranges, particularly of the areas lying between Nunivak Island and Kotzebue Sound, is given in Table 1. The general occurrence of the types is indicated and their relative forage value, the forage value as here used being derived by multiplying the percentage of density of forage stand by the percentage of palatable plants.

B22737

FIG. 1.—NORMAL SUMMER RANGE.

On the coast of Norton Sound. Forage of the sedge, or tundra, type.



B22734

FIG. 2.—OVERGRAZED RANGE.

The result of close herding. On the coast of Norton Sound.

TABLE 1.—*Summary of principal forage types occurring on the coast reindeer range between Nunivak Island and Kotzebue Sound.*

Type.	Subtype.	Average forage value.[1]	Distribution.
Lichen		5.00	Ridges and interior hills; fall and winter range.
Do	Sedge	5.25	Do.
Do	Browse	5.50	Do.
Do	Grass	4.25	Do.
Sedge		6.00	Tundra types—on flats, benches, and lower slopes; summer and fall range.
Do	Browse	5.70	Do.
Do	Lichen	6.35	Do.
Do	Grass	4.95	Do.
Conifer		3.20	Along rivers and creeks.
Do	Grass	3.20	Do.
Do	Browse	3.90	Do.
Do	Lichen	2.50	Do.
Browse		4.45	Slopes and ridges; summer range.
Do	Grass	3.50	Do.
Do	Sedge	5.40	Do.
Grass		4.00	Over relatively small areas on sandy spits; coast types of summer range.
Do	Browse	5.00	Do.
Do	Weed	3.00	Do.

[1] Derived by multiplying the percentage of density of forage stand by the percentage of palatable plants.

TABLE 2.—*Summary of principal forage types occurring on some of the far interior reindeer ranges, particularly over the Broad Pass, Gulkana, and Tangle Lakes region.*

Type.	Subtype.	Average forage value.[1]	Distribution.
Lichen		5.75	
Do	Browse	6.50	Ridges, upper slopes and benches, and glacial canyons.
Do	Browse, weed	4.80	Upper steep slopes.
Do	Grass	6.00	Foothills of upper drainages.
Browse		6.40	
Do	Lichen	6.50	Lower ridges and slopes, and shallow draws of benchlands.
Do	Grass	6.15	Old burns, and in open parks in timber.
Do	Weed	6.65	Lower slopes.
Grass	Lichen	6.85	Benchlands.
Conifer	Browse	5.40	Along draws and around lakes.

[1] Derived as in Table 1.

FORAGE GRAZED BY REINDEER.

A complete list of the range forage plants observed and collected on the reindeer ranges in Alaska will be found on pages 70 to 74. The forage plants observed to be grazed by the reindeer during both summer and winter on the coast ranges are summarized in Tables 3 and 4, in which the species are grouped according to the proportions they form of the forage eaten, those in the "first series" being most generally used; the "second series" being next in importance; and the "third series" those which are grazed only incidentally.

The forage in the first series is of generally high palatability and the most extensively grazed, not only because of this but because of

its greater abundance. On the other hand, plants in the second series are of equally good quality, but are not eaten so much, chiefly because they are less abundant. The plants in the third series are generally of lower palatability. The division into groups indicates the relative degree of palatability within each series.

TABLE 3.—*Plants grazed in summer, in the order of their importance.*

First series:
- Group I—
  - Small cotton sedge (*Eriophorum callitrix*).
  - Large cotton sedge (*Eriophorum angustifolium*).
  - Willows (*Salix*) (several species).
  - Reindeer moss (lichens) (*Cladonia*).
  - Iceland moss (lichens) (*Cetraria*).
- Group II—
  - Ground birch (*Betula rotundifolia*).
  - Alaska tea (*Ledum palustre* and *groenlandicum*).

Second series:
- Group I—
  - Blueberry (*Vaccinium uliginosum*).
  - Mountain cranberry (*Vaccinium vitis-idaea*).
  - Crowberry (*Empetrum nigrum*).
  - Sedges (*Carex*).
  - Grasses (*Poa; Arctagrostis; Festuca; Agropyron*).
  - Water buttercup (*Ranunculus pallasii*).
  - Valerian (*Valeriana capitata*).
  - Fernweed (*Pedicularis verticillata*).
  - Wormwood (*Artemisia tilesii*).
  - Wormwood (*Artemisia arctica*).
  - Fireweed (*Epilobium angustifolium*).
- Group II—
  - Mushrooms.
  - Gentian (*Gentiana glauca*).

Second series—Continued.
- Group II—Continued.
  - Dryad (*Dryas octopetala*).
  - Lupine (*Lupinus*).
  - Vetch (*Vicia*).
  - Polygonum (*Polygonum alaskanum*).
  - Dock (*Rumex occidentalis*).

Third series:
- Group I—
  - Alder (*Alnus alnobetula*).
  - Salmonberry (*Rubus chamaemorus*).
  - Alpine bearberry (*Arctous alpina*).
  - Diapensia (*Diapensia lapponica*).
  - Clubmoss (*Lycopodium annotinum*).
  - Heath moss (*Polytrichum*) (several species).
  - Bunch moss (*Aulacommium turgidum.*)
  - Fern moss (*Hylocomium alaskanum*).
  - Horsetail (*Equisetum arvense*).
- Group II—
  - Water starwort (*Merckia physodes*).
  - Beach pea (*Lathyrus maritimus*).
  - Timber bluebells (*Mertensia paniculata*).
  - Fernweed (*Pedicularis*).
  - Gentian (*Gentiana*).
  - Birch (*Betula kenaica*).
  - Spiraea (*Spiraea steveni*).
  - Parsnip (*Coelopleurum gmelini*).
  - Hemlock parsley (*Conioselinum gmelini*).

TABLE 4.—*Plants grazed in winter, in the order of their importance.*

First series:
- Reindeer moss (lichens) (*Cladonia*) (numerous species).
- Iceland moss (lichens) (*Cetraria*) (numerous species).

Second series:
- Group I—
  - Cotton sedges (*Eriophorum*).
  - Sedges (*Carex*).
  - Grasses (*Arctagrostis; Poa*).
  - Ear lichen (*Nephroma arcticum*).
- Group II—
  - Heath moss (*Polytrichum*) (several species).
  - Bunch moss (*Aulacommium turgidum*).
  - Clubmoss (*Lycopodium annotinum*).

Second series—Continued.
- Group II—Continued.
  - Fern moss (*Hylocomium alaskanum*).
  - Sphagnum moss (*Sphagnum fimbriatum*).
  - Pad moss (*Dicranum*) (several species).

Third series:
- Willows (*Salix*).
- Blueberry (*Vaccinium uliginosum*).
- Ground birch (*Betula rotundifolia*).
- Crowberry (*Empetrum nigrum*).
- Alaska tea (*Ledum palustre*).
- Mountain cranberry (*Vaccinium vitis-idaea*).

GRAZING PERIODS AND CLIMATE.

Reindeer raising is entirely a range proposition, involving year-long grazing, with, generally speaking, a winter season varying from seven months on the coast range to six or six and a half months in the far interior. On the coast the grazing periods run about as follows: Spring, or fawning period, April 10 to June 10; summer, June 10 to September 15; fall, September 15 to November 15; winter, November 15 to April 10.

The seasonal periods applicable generally to reindeer grazing in Alaska are indicated roughly in Table 5, which includes figures on temperature and precipitation as recorded from climatological data collected by the United States Weather Bureau. Data are given for only a few widely scattered stations, but are thought sufficiently representative to afford a general idea of the climatic conditions covering the main reindeer area.

TABLE 5.—*Climatological data, by seasonal periods at various Alaska stations for the year 1919.*

Stations and districts.	Temperature (°F.).			Precipitation (inches).		
	Years recorded.	Annual mean.	Lowest.	Years recorded.	Total annual.	Snowfall.
Dutch Harbor, Aleutian Islands	18	39.5	5	18	64.98	5.0
Naknek, Bristol Bay	3	34.3	−43			
Holy Cross, Yukon River	17	28.3	−58			
Nulato, Yukon River	2	23.4	−57	3	17.18	68.4
Tanana, Yukon River	19	23.6	−66	19	13.33	21.5
Fairbanks, Tanana River	14	26.4	−56	14	11.44	29.6
Unalakleet, Norton Sound		23.6	−49			
Nome, Seward Peninsula	12	25.3	−47	12	19.04	54.9
Candle, Seward Peninsula	9	20.3	−60			
Akiak, Kuskokwim			−57			
Salmon River (Kuskokwim)						

TABLE 5.—*Climatological data, by seasonal periods at various Alaska stations for the year 1913*—Continued.

Stations and districts.	Seasonal periods. (Spring: April–May; summer: June–September; fall: October–November; winter: December–March.)							
	Mean temperature.				Total precipitation.			
	Spring.	Summer.	Fall.	Winter.	Spring.	Summer.	Fall.	Winter.
Dutch Harbor, Aleutian Islands	36.5	49.9	40.2	30.3	9.47	11.73	11.65	32.13
Naknek, Bristol Bay	36.9	53.0	29.2	16.6	3.61	11.29	4.40	3.03
Holy Cross, Yukon River	36.7	50.2	22.4	4.9	.72	13.17	4.83	.18
Nulato, Yukon River	31.7	49.3	15.1	−2.5	.70	9.25	4.57	2.66
Tanana, Yukon River	36.3	51.2	10.6	−4.0	.84	9.05	2.10	1.34
Fairbanks, Tanana River	41.3	55.2	13.6	−3.3	1.49	6.92	2.14	.89
Unalakleet, Norton Sound	28.8	46.9	17.0	1.2	.....	.....	.....	.....
Nome, Seward Peninsula	26.2	44.5	22.6	7.2	.52	10.94	4.61	2.97
Candle, Seward Peninsula	19.9	45.7	19.5	−4.4	.16	5.86	.73	.....
Akiak, Kuskokwim	35.5	.....	18.4	.....	.46	.....	.77	.....
Salmon River (Kuskokwim)	36.9	52.8	16.6	.....	.....	.....	.....	.....

RANGE MANAGEMENT.

No cultivated forage crops are raised and no feeding is done in connection with reindeer grazing. The individual grazing allotment, by which is meant a special kind of stock ranch, represents the requirement for maintaining a herd and includes summer and winter ranges and fawning grounds. Consequently the utmost care must be exercised and the best management maintained to insure a permanency of pasturage with a continued forage crop from year to year.

All improvements, such as buildings and corrals for each herd, should be constructed on the individual grazing allotment. The ideal arrangement would be, with definite allotments established, entirely to fence each unit, particularly the summer range, and turn the reindeer loose within the inclosure to graze at will. Such a plan at this time, however, is not financially practicable. With improved methods of handling and control, grazing on the open range may in effect be made to approach this ideal, which implies more natural and open grazing. Under present handling, the tendency is to close herd and graze the reindeer more on the order of the old methods of handling range sheep. The tendency should be toward open herding and grazing, more like the handling of range cattle in the Western States.

Unlike much of the reindeer grazing conducted by the Lapps in northern Sweden and Norway, where a nomadic existence is common, reindeer grazing in Alaska is more centralized and tends rather toward permanent ranches. This is largely due to the habits of the Eskimos and to the presence in Alaska of larger natural grazing units which may be divided into individual grazing allotments each complete in itself. The nomadic habit of the Lapp requires that

he handle his reindeer under a close-herding practice; but in Alaska, to secure the best results under a fixed allotment system, the opposite, or open herding, must generally be practiced.

CARRYING CAPACITY.

In any successful range management a consideration of grazing or carrying capacity is a matter of primary importance. By this is meant the number of stock which a range will support for a definite period of grazing without injury to the range. To attain the greatest carrying capacity, both overgrazing and unnecessary undergrazing must be avoided.

Carrying capacity estimates.—From the surveys thus far made, it appears that the range requirement for each reindeer is about 30 acres. This closely approximates the acreage required by cattle on national-forest areas in the Western States, where it runs on an average about 2 to 2½ acres per cow per month,[9] or roughly, between 20 and 30 acres a year. Some Norwegian figures give 25 to 28 acres a year in reindeer grazing. Specific observations thus far made on carrying capacity on two reindeer allotments in the vicinity of Unalakleet indicate 30 acres a year as a maximum requirement for mature animals exclusive of fawns. By including the fawns, on a basis of two fawns to one mature animal, the requirement becomes 26 acres a year. It will be borne in mind, however, that observations at Unalakleet were of necessity very general and involved largely range of the wet tundra type; more detailed work is planned to cover all important conditions.

The maximum range-carrying capacity is not realized and the acreage requirement is naturally higher under poor management. Present conditions of poor distribution of reindeer, close herding, and mishandling require large ranges. With an approach to the ideal in management, and a decrease in the present acreage requirement, a higher carrying capacity for each range unit should be developed. In determining carrying capacity, the matter of class of production must also be taken into consideration. As reindeer are now grown entirely on the range, without feeding, it is obvious that for the production of fat stock for marketing purposes a larger acreage per animal is required than for ordinary range stock.

GRAZING UNITS.

To control the number and distribution of reindeer on a given area is a fundamental requirement for effective range management. This may be attained by regulating the use of the range by a system of permits for definite grazing units, or allotments.

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[9] Jardine, James T., and Mark Anderson, Range management on the national forests: Bull. No. 790, U. S. Dept. Agr., pp. 28–29, 1919.

In allotting the range for natives or other small owners large community units rather than numerous small individual allotments should be the rule. The topography of the country and the advantage of handling reindeer more like cattle than sheep requires large range allotments for economical and efficient management. Allotment units should include winter, summer, and fawning range. It would be impracticable to make smaller subdivisions to meet the requirements of owners of varying small herds, with the necessary provision for seasonal grazing; such allotments would make it hard to control individual herds and to prevent losses.

While reindeer can be handled successfully on the range, they are not so amenable to control as are sheep. Herding must be done by men on foot aided by dogs, but open herding on large ranges to insure proper range use is the best method of handling a reindeer herd and approximates more nearly cattle grazing. As in cattle grazing, the maintenance of necessary control between allotments is more of a problem than with sheep, and emphasizes the need of larger grazing units as against a small checkerboard system. Aside from this the cost of running large herds will be less in proportion than in smaller ones, and will thus increase efficiency in control and economy in production. Anticipating the filling up of the ranges to their carrying capacity, small owners, particularly the Eskimos, should begin promptly to organize community or cooperative herds with a view to holding the necessary grazing areas.

OVERGRAZING.

Overgrazing has been defined as "grazing which, when continued one or more years, reduces the forage crop or results in an undesirable change in the kind of forage."[10] It may be general over an entire range unit, caused by overstocking; or it may be merely local and due to poor distribution of the stock or improper handling. In Alaska, under present practice, local overgrazing often results from both of these causes, and general overgrazing from overstocking does not occur.

What local overgrazing there is at present may be attributed mainly to the method of handling—involving close herding (Pl. XIII, Fig. 2); to holding the herd on a relatively small piece of range year after year; and in some cases close to the coast to using the same range both summer and winter. This localizing of the herds is largely due to the introduction of close herding by the Lapps and to the fact that the average native is inclined to stay near his village and the coast, where he may devote part of his time to fishing or hunting seals. Many of the natives working with the herds have not become essentially reindeer men, but remain, as for-

[10] Jardine, James T., and Mark Anderson, Op. cit., pp. 16–29.

merly, fishermen and hunters. Confinement of herds to small areas is not due to lack of range or to crowded allotments; on the contrary there is an abundance of available range. There has been little or no attention given to the matter of carrying capacity, or to the fact that with an increase in numbers of stock it becomes necessary to use more range.

One result of close herding is a cutting up of the range by the sharp hoofs of the reindeer, which in some cases causes serious injury to the forage cover. Holding the herd locally under close herding thus means localized mechanical injury to the range in addition to overgrazing. The remedy, of course, is open herding, which implies the spreading of the herd over more territory and a movement from point to point, thus materially lessening the possibilities of damage, and maintaining the recuperative power of the range as a whole. The matter of open herding is treated under the subject of Distribution and Control (p. 36).

To determine whether overgrazing is taking place, both the condition of the range and the condition of the stock must be watched. The extreme stage of overgrazing is marked by denudation, in the form of erosion and barrenness, replacing a former vegetative cover; but this form does not as yet occur in Alaska, except for small examples on old corral grounds.

Overgrazing does not necessarily imply complete destruction of the vegetative cover. On most ranges there is at least a small growth of plants of which the reindeer will eat very little except in case of necessity, and a range should not be grazed until the stock are reduced to feeding on forage of low palatability. Close grazing of this class of vegetation is an indication that the range is overgrazed, and it is soon reflected in the condition of stock, which is apt to be unsatisfactory, as shown by poorly nourished animals and particularly by a heavy infestation of parasites. Parasitism and overgrazing commonly go together, the degree of infestation often being in direct ratio to the extent of overgrazing.

The considerable area of tundra on the summer range present an important factor bearing on range utilization, particularly in the case of the wet tundra type along the coast. Owing to the soft wet ground, this class of range is much more susceptible to injury, chiefly through trampling and contamination, than the drier sites, as is plainly indicated by cut-up ground and trampled forage. In extreme examples there is a close network of stock trails between the hummocks, leaving the latter standing up in sharp relief against a background where the former vegetation has been killed or eaten. Under this condition an absence of some of the more palatable forage plants and a greater cropping of the less palatable may be noted on the hummocks themselves.

DEFERRED AND ROTATION GRAZING.

Good herding management and a correction of misuse of the range through the practice of locally confining the herd necessitates employment of the principles of deferred and rotation grazing. This involves use of the range under a system which will permit a maximum of grazing and at the same time a natural reproduction of the forage crop in such way as to maintain the relation of grazing to these requirements at different stages of growth.

The following principles developed by observations of sheep and cattle grazing on the national forests of the western United States[11] will apply as well to Alaskan reindeer grazing:

(1) Removal of the herbage year after year during the early part of the growing season weakens the plants, delays the resumption of growth, advances the time of maturity, and decreases the seed production and the fertility of the seed.

(2) Under the practice of yearlong or season-long grazing, the growth of the plants and seed production are seriously interfered with. A range so used, when stocked to its full capacity, finally becomes denuded.

(3) Grazing after seed maturity in no way interferes with flowerstalk production. As much fertile seed is produced as where the vegetation is protected from grazing during the whole of the year.

(4) Deferred grazing (grazing after seed maturity) insures the planting of the seed crop and the permanent establishment of seedling plants without sacrificing the season's forage.

(5) Deferred grazing can be applied wherever the vegetation remains palatable after seed maturity and produces a seed crop, provided ample water facilities for stock exist or may be developed.

(6) Yearlong protection against grazing of the range favors plant growth and seed production, but does not insure the planting of the seed. Moreover, it is impracticable, because of the entire loss of the forage crop.

Based on the above principles, the system of deferred and rotation grazing aims to minimize the injury from grazing during the early and main growth periods of the vegetation (1) by having each portion of the range bear its share of the early grazing and (2) by protecting each portion of the range in its turn until after seed maturity, so that the main forage plants will regain their vigor and reproduce either from seed or vegetatively.[12] This may be accomplished by dividing the grazing unit into three or four parts of about equal carrying capacity, in such way as to give the best control of stock on each portion, and by rotating the time of grazing from year to year progressively between these areas so as to give both deferred and early grazing to each in turn.

At this time, on Alaskan ranges, deferred and rotation grazing can best be secured on parts of the range unit where localized over-

[11] Sampson, Arthur W., Natural revegetation of range lands based upon growth requirements and life history of the vegetation: Journ. Agr. Research, U. S. Dept. Agr., vol. 3, no. 2, pp. 93–148, 1914.

[12] Jardine, James T., and Mark Anderson, Op. cit., pp. 60–65.

grazing has taken place by herding away from the area until after seed maturity of the important forage plants; this can be helped eventually by salting (see p. 37). For the range unit as a whole, deferred and rotation grazing can be accomplished to an important extent simply by alternating the plan of grazing over the allotment from year to year.

EXISTING REGULATIONS AND RANGE CONTROL.

Existing regulations governing the grazing of reindeer in Alaska apply essentially to the early stages of the native industry;[13] as they were adopted prior to the building up of large herds under white ownership, they do not now fill the requirements. A new plan of regulation and control has become necessary to cover the herds under both native and white ownership and to correlate the two interests in such manner as to insure the protection of both classes. In fact such reorganization is a first essential toward building up the Alaskan reindeer industry.

Improved methods of management are vastly important but faulty basic organization may offset all the good range management that may be effected. Such basic problems as determination of ownership, industrial relationship between the native, the Lapp, and the other white men, proper supervision and organization of herds, and rights to and control of range lands, all need early consideration.

Jurisdiction over the range in Alaska does not at the present time come under any vested authority. The areas now allotted to individual reindeer herds of the Eskimos were established tentatively by the Bureau of Education. They are maintained by tolerance only and invasions of ranges are common. Legally there is no protection against encroachments upon individual allotments. Without right to control the range upon which to graze, reindeer-herd owners are much handicapped. Control of the range stands as a principal factor for consideration in handling the future reindeer industry in Alaska.

HERD MANAGEMENT.

Reindeer handling in Alaska suffers greatly from lack of application of improved modern methods. The growth in the numbers of reindeer has been very rapid, but correspondingly improved general organization, and better methods of controlling parasites and diseases have failed to keep pace with it. Consequently the industry has developed to large proportions under conditions which urgently need improvement to insure continued healthy progress. Generally,

[13] Rules and Regulations Regarding the U. S. Reindeer Service in Alaska: Bureau of Education, Alaska Reindeer Service, U. S. Dept. Int. Whole number 466, Dec. 7, 1911.

the method of handling now employed follows the Old World practices, and these often are built up on superstitious beliefs or old customs, and have, to a large extent, apparently missed the influence of modern ideas. Reindeer grazing does not differ so greatly from other live-stock handling that the same principles of management are not generally applicable. The improved practices in handling live stock employed in the Western States apply equally in general principles to the handling of reindeer in Alaska.

Among other things, the Eskimo herd owners greatly need corrals and cabins (Pl. XIV, Fig. 2) on the grazing areas to promote better herd management. Lack of proper corralling facilities is preventing the accurate marking of stock and the making of counts and ownership records of many of the native herds, some of which have not been counted for several years. Often in the larger bands only a part of the fawn crop is being successfully marked each year, and unmarked yearlings are commonly noted in the herds. Aside from entailing confusion in ownership and leaving an opening for "rustling," this lack of corrals otherwise impedes proper supervision.

Without cabins on the winter range, in many cases the reindeer are held on the same ground along the coast both summer and winter. This, of course, damages the range and jeopardizes the herd when the snow crusts over. Proper winter range lies in the hills back of the coast, where there are protected areas with an abundance of reindeer moss. Consequently, winter quarters should be established away from the coast villages, and this requires the construction of cabins in the hills on the seasonable ranges.

Unless the reindeer industry is put on a good commercial basis, there will be little incentive for investment in stock, and the herds will be of value only for the owner's individual needs and for a very limited local sale. Consequently, if its greatest development is to be attained, it will be necessary for white interests with capital and initiative to take a leading part. If development of the industry should be confined mainly to the natives, progress will be relatively slow, since, unaided, they have not the ability, knowledge, or means to develop it.

SUPERVISION OF HERDS.

In any event, better supervision of the native herds is necessary to care properly for them. Such care and protection is important not only in view of the natives' food and clothing requirements, but also because of the need for meat production to aid in fostering local white enterprises in the Territory.

The native herds are scattered throughout the present coast range on all grazing units, irrespective of white or native occupancy. Thus reindeer of both natives and whites often graze cooperatively on the

same range, and in such instances all the animals come under white management. Except where cared for in a white man's herd, the Eskimo reindeer are generally rather badly managed because of the improper methods employed and the lack of trained supervision. The teachers at the Eskimo schools maintained by the Bureau of Education are doing all they can to supervise the management of the herds of the people at their stations, but they are not skilled in animal husbandry, and their other duties occupy their time. The assistance of a small organized corps of trained white men to look after the native herds and supervise their development along improved practical lines is urgently needed.

COMMUNITY HERDS.

The organization of herds on a cooperative basis, as proposed and recently initiated by the Bureau of Education, will not only secure proper and definite allotments of range but will promote more effective management of both herds and ranges. Such organizations among native owners will make possible the employment of the best reindeer men for herding and prevent interference and meddling by others. It will make possible uniformity in distribution of herders between bands, establish adequate and just remuneration for them, and eliminate the inefficient herder who could put in his time to better advantage in fishing and hunting. It will result also in the adoption of one distinctive earmark or brand for the combined herd, and in a centralization of herd management, either in a white superintendency or in an advisory board of the leading natives under white supervision.

In larger herds under the cooperative plan herd management will be much simplified. Gain and loss in the herd will be prorated among the individual owners, and it will be easier to guard against "rustling," which may grow to serious proportions. The supervision of native holdings by the Government also will be greatly simplified and made more effective.

SIZE OF HERDS.

In Alaska, reindeer are now run in herds of from less than 400 up to 5,000 head, and in one case 8,000. While the future tendency will be toward the larger herds, under existing conditions it appears to be preferable, for the present at least, that the Eskimo reindeer be run in herds of medium size. In the absence of proper corrals, in order to insure less complicated handling, particularly for marking and counting, these should not be larger than 1,000 to 1,500 head each.

Where a cooperative organization includes several small bands or herds, this should not necessarily imply uniting all of them in one

band on the range. When two or more large bands are under one ownership, they should be maintained so far as practicable in separate herds on distinct grazing areas or on separate portions of a large unit. On the other hand, when two or more small bands are held by the same owner they can usually be combined to considerable advantage, provided they do not make the one herd too large.

The greatest number of reindeer that may be run economically in one band under present methods of handling has not yet been determined. It may be pointed out that with the present distribution within a grazing unit, it may be for the best interests of both the range and the animals to run two or more medium-sized bands than one very large one.

The following points should be carefully considered: A very large band, unless very openly herded, will do proportionately more injury to the range than a smaller band. On the other hand, other things being equal, it may cost as much to herd the small band as a medium-sized one. A large mixed herd may be run probably without undue injury to the range if before fawning time the does can be successfully segregated from the bucks, steers, and yearlings, and during the early part of the season the two groups run separately.

DISTRIBUTION AND CONTROL WITHIN UNIT.

Grazing units having been established and definite numbers of stock allotted to each, the next problem will be to realize the best use of the forage within each allotment. This requires such control of the stock within the allotted grazing area as to bring about full and uniform grazing. Steps to be taken to this end include herding, salting, and the construction of needed range improvements, such as fences and cabins.

Herding.—Open herding is the best method of handling reindeer to avoid damage to the range and to secure the best results in the herd. In close herding, as frequently practiced in Alaska, the stock is held closely banded together at all times, whereas in open herding the animals are allowed to graze spread out on the range. In the latter case herding consists chiefly in making a big circle around the band each day, without disturbing it, but working in the few strays that get too far away from the outer grazing circle.

While permitting the herd to spread loosely on the range and involving less handling or disturbance, open herding must not be thought of as implying lax herding, in the sense of turning the animals loose to wander over the country at will, to be herded only at intervals. Proper open herding requires constant attention, but with as little disturbance of the herd as possible, thereby maintaining a more natural and wide-spread grazing on the particular range

B22670

FIG. 1.—REINDEER HERDERS ON ST. LAWRENCE ISLAND.

These Eskimos are enthusiastic reindeer men and are eager to learn all they can about the reindeer business.

B22652

FIG. 2.—HERDER'S CABIN.

Chief Lapp herder and Eskimo assistant in front of cabin on the Egavik range. Herd dogs in the foreground.

area used. Unless the herd is constantly watched material losses are sure to result through straying.

Reindeer herding is now done entirely on foot, mainly by natives and Lapps, commonly aided by dogs (Pl. XIV, Fig. 1). One or two herders go out each day from a central camp to watch the herd, sometimes remaining out over night. The herd dogs are generally of small size and compare quite unfavorably with a good cattle or sheep dog. Improvement in the breed of reindeer dogs is desirable and would aid greatly in attaining better herding.

For bands numbering on the average from 1,000 to 1,500 head, usually three herders are employed, with extra help during the marking season. Herds numbering from 2,000 to 5,000 require a herd superintendent, a chief herder, and three good herders during the greater part of the year, with extra help to insure fast work at marking and butchering time, usually 20 or 25 men for a few days.

Salting.—Salting, said to represent the best herder the cattleman has, is considered as offering the greatest possibilities for maintaining a proper distribution of cattle on the range, and it is believed that it may likewise be developed as a major factor in controlling reindeer grazing. By its use, considerable improvement in the distribution of stock and utilization of range is made possible. Reindeer salting will be similar to salting cattle and the same principles should apply.

Reindeer are very fond of salt, and when neld along the coast they get it during the summer season by drinking the sea water or licking up the deposits on the beach. Along with the fly pest, this undoubtedly serves as an important factor in urging them to the coast during the summer months.

The salting now being done on a small scale in Alaska by a few of the white reindeer owners is with crushed rock salt. This is placed on the range usually by scattering handfuls on rocky ground. On one allotment in the summer of 1921 a small amount of experimental salting was begun, using both the crushed rock salt and the block salt. The owner reported that so far he has found that the reindeer are very fond of the crushed salt, but that they scarcely touch the block salt. This may be significant as indicating that it may be found necessary to use crushed rock salt exclusively for reindeer. Salt in both forms will be thoroughly tried out in the experimental projects undertaken by the Biological Survey. If found equally acceptable to the animals, block salt would be preferable as being more convenient to handle and transport. Crushed rock salt would probably require troughs to use it in an economical manner.

Fencing—Open herding and necessary control between adjoining grazing units, particularly on the summer range, may be facilitated

by the construction of short division fences in many localities. Fencing at this time, however, should not be considered a major requirement in reindeer grazing, but more as an expedient that may be resorted to in some places to obtain better stock control. In the more heavily timbered ranges of the interior, fencing no doubt will prove more of a necessity, not only for control but for protection as well.

The greatest use of fencing is to insure against mixing of herds in certain cases on adjoining allotments, especially where there are no natural barriers along the boundary lines. As the ranges become fully stocked the need for such fences will be more and more evident and they will be a necessity in some cases if allotments are to be fully utilized and if herds are to be prevented from mixing along the boundaries of adjoining allotments. In the absence of fencing the tendency will be to confine the herd as much as possible to the inner portions of the allotment, thus leaving a belt of unutilized range along the boundary lines, resulting in a material loss of range. Fencing along such boundaries would permit grazing up to the allotment lines and thus eliminate loss. The mixing of herds involves much labor and time in corralling and separating the animals and often results in injury to the stock as well as to the range where the herds are closely held. Absence of fencing will tend to increase the size of allotments to make up for the ungrazed borders.

The problem of control between grazing units may be greatly lessened by careful selection of allotment boundaries, careful herding, and perfection of systematic range management. In locating allotment boundaries, advantage should be taken of such natural barriers as streams, prominent ridges, and other major topographic features.

Fencing within the grazing unit may later be of value as an aid in the following respects. To better control deferred and rotation grazing; to segregate breeding stock from nonbreeding stock; to control stock in timbered sections; to maintain holding pastures for stock during a round-up, either in connection with cold storage plants or with marking and separating corrals.

Careful herding at all times is of prime importance to prevent mixing, but cooperative arrangements between owners of herds on adjoining allotments should evolve a system of rotation grazing whereby each allotment area may be almost fully utilized by having only one herd near the border at any time. The practicability of fencing any particular allotment should be considered from the viewpoint of ground site, availability of material, and expense of construction as related to maintenance cost of the herd as a whole. Fencing even at this time will not take the place of efficient herding if it can be procured.

Construction of cabins.—Reindeer herding deals with large acreages, a country of sparse settlement and poor transportation facilities, and traveling over the range on foot, usually under adverse conditions. Consequently there is great need for the erection of shelters or cabins for the herders here and there on the range (see Pl. XIV, Fig. 2). At least three main cabins are needed on the average allotment—one headquarters cabin on the summer range, one headquarters cabin on the winter range, and one cabin on the fawning grounds. In addition to these, and depending upon the size and character of the allotment, the construction of several subsidiary cabins or shelters at strategic points over the range will facilitate the work of moving herds about the range and handling them with less confinement and disturbance. In some instances, tents may suffice, but a permanent shelter is preferable, since this will be more comfortable and permit the storage of necessary supplies at favorable periods in the year and save much labor where transportation is difficult.

The construction of necessary cabins is not difficult in timbered sections of the country; but where there is no timber, as over the major portion of Seward Peninsula and along the Arctic coast, the problems of material for cabins, of available fuel, and of transportation are serious, especially so on treeless winter ranges. Material is readily available for the summer on the coast of Bering Sea in the form of beach driftwood and of lumber brought in in a few instances by boat for building purposes, while driftwood, willows, and natural lignite serve for fuel.

Much of the fuel and building material for cabins on the winter ranges of the Seward Peninsula must be transported into the hills from the coast. In some cases this will prove difficult, and in a number of instances it is this very difficulty of building a new winter headquarters that is holding the herd on old and fed-out ground when it should move on to new range. However, while transportation of material to desirable winter-range sites on the Seward Peninsula or elsewhere may not be attempted under present conditions, it undoubtedly will be in the future through large holdings under individual or cooperative management.

GRADING UP THE STOCK.

It is apparent that little or no thought has been given in Alaska to the proper breeding of reindeer. Exchange of blood between herds has been more a matter of accident than design. It is especially important that more attention be paid to the selection of herd bucks. At present there are too many undesirable small bucks doing service, and in too many cases the larger animals, which should be heading the herds, are castrated and later killed to supply the meat demand.

Not more than 5 bucks are necessary for 100 does, and records indicate that even less than this number may suffice. In one instance, a ratio of only 1 to 30 was maintained with successful results, and in another case the ratio was 1 to 44. All bucks not needed for breeding purposes should be castrated and grown as steers (Pl. XV, Fig. 1).

The female side of the better breeds question must also be considered. Old does are either unproductive or have weak fawns, so that it is highly desirable to cull out a percentage of them each year. These animals should be separated or marked sufficiently early in the year for the unproductive ones to be easily identified, and they may be profitably butchered either before or soon after the rutting period. In addition to the old does, all stunted, sickly, or otherwise undesirable animals should be disposed of.

In other breeds of domesticated animals the present cry is to eliminate the scrub. By applying this practice just as rigorously in the reindeer business, and by introducing the practice of selective breeding, the first and most important step will have been taken toward establishing a better grade of stock.

Crossing with caribou.—Experiments are being planned to introduce caribou bulls into a herd of reindeer in which the reindeer bucks will first be castrated. The woodland caribou is a much larger animal than the reindeer, and dressed weights of over 300 pounds are common, while the average dressed weight of reindeer steers is only 150 pounds. The mixture of caribou blood will undoubtedly have a decided effect in increasing the weight of the animals. In addition to the introduction of the large caribou bulls, a carefully conducted program will be carried out of permitting only the best reindeer stock to breed, the undesirable or scrub males and females being weeded out. It is believed that reindeer may be brought up to double their present weight and that this program of improved breeding can be generally introduced throughout Alaskan herds. It is planned to conduct the experiment on an island where there is only one herd. This will eliminate the chance of error by the intermingling of stray animals. It may be stated that caribou mix readily with reindeer and they are constantly being seen in the herds. Unfortunately this is generally late in the season after rutting time, and besides this the caribou are wild and do not remain for long periods in the herd. These difficulties will be eliminated in the proposed experiment, which should mean much to the reindeer industry.

HANDLING THE HERDS.

ROUND-UPS.

Numerous round-ups (Pl. XV, Fig. 2) for trivial reasons and much driving of the reindeer during round-ups and on the range result in injury to both herd and range and in loss in weight of the

B20465

FIG. 1.—REINDEER STEER.

A well-built blocky type of meat-producing animal. Such reindeer are less numerous in the herds than could be desired, but by selection of breeding stock they can be made predominant and greatly to add to the meat output. (Photographed September 26, 1920.)

B20513

FIG. 2.—ROUNDED-UP HERD.

Photographed at Norton Sound in the summer of 1920. When reindeer are rounded up, even in the open, they crowd into a compact mass like a herd of sheep.

B22614

FIG. 1.—A WINTER ROUND-UP.

Eskimo herd on the winter range on Golsova River, February 25, 1921.

B22638

FIG. 2.—HERDING TOWARD THE CORRAL.

By establishing the corral just over the brow of a hill, as in this case, the reindeer find themselves practically inside before they see it. Wing fences of brush or other material running out from the corral guide them to the entrance.

animals, and must be avoided if the best results for the herd are to be obtained. Where there is no central management and lack of concerted action in handling herds among the various owners, the tendency is for frequent round-ups throughout the year for the convenience of individual owners, without regard to the common interest or the welfare of the herd as a whole.

In a systematic business management of the herd, round-ups will be reduced to a minimum and the necessary handling of the animals planned to fall as far as possible into three main periods: (1) a spring round-up for counting, marking, and castration of fawns; (2) a fall round-up for cutting out steers for market; and (3) a winter round-up for separating breeding from nonbreeding animals. Round-ups between these periods, unless absolutely necessary, should be avoided.

In fixing the round-up periods consideration should be given to the time of year that the herd may be handled with least injury. The spring round-up should take place early in June prior to the fly season, which begins toward the end of the month. The fall round-up should be during the period that the animals are in best condition for butchering, and when handling is practicable; this is generally at the close of the summer grazing and after the rutting period. The winter round-up (Pl. XVI, Fig. 1) should be in the fore part of the season, since toward the end of winter the females are heavy with fawn and consequently should not be disturbed. When a round-up is to take place, all interested parties should be duly notified. If an individual fails to avail himself of the opportunity to cut out or otherwise handle his stock, he should not be permitted to have a special round-up later for individual work.

CORRALS.

The corral method generally employed at present is to rope in a crude brush or pole inclosure on the open range. This usually involves handling the herd for a long period, often requiring two or three weeks, and as a general rule results in considerable losses of animals injured or killed outright. If these losses are to be eliminated, roping must be reduced to a minimum and as much of the handling as possible done in a corral arranged with separating pens and chutes. In any case, greater care must be taken in handling the animals.

On most allotments two corrals are used, one on the summer and another on the winter range. The main corral is on the summer range and is usually built near or on the beach, ordinarily of driftwood, brush, and green poles, or sometimes lumber, wire, and burlap. On the winter range a brush corral is usually constructed. The

summer corral is used largely for marking, castrating, and counting, and the winter corral for separating purposes and for cutting out animals for slaughter.

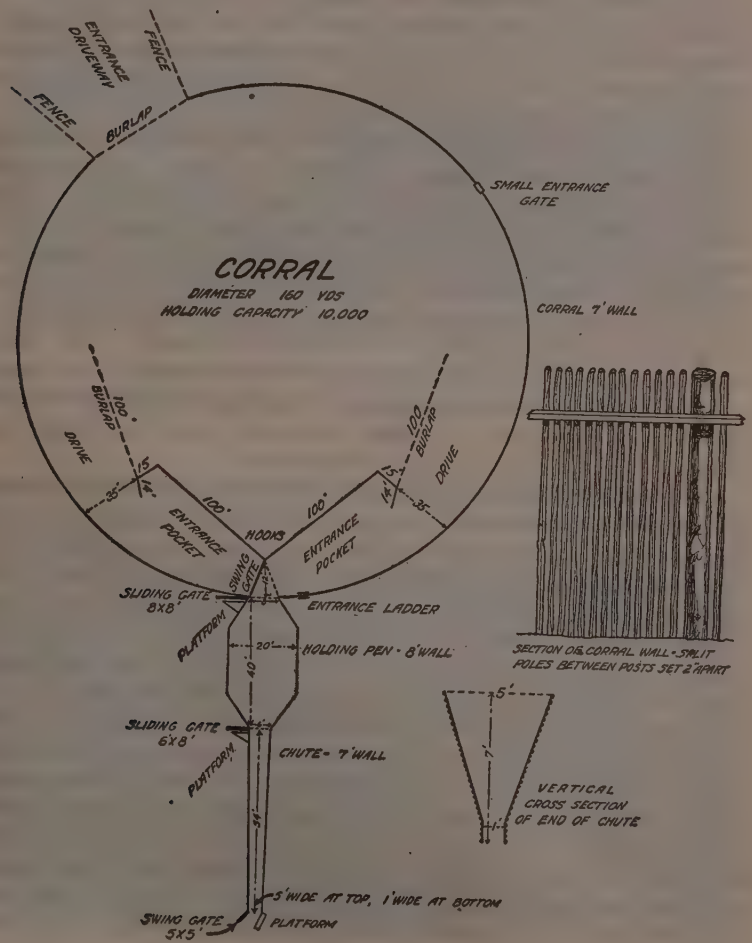
Many of the bad features under the present methods of corralling can be overcome by building proper chutes connected with the corrals. The time now taken in separating a herd by the roping method is much too long. In one case, a herd was worked 9 hours on each of two days, with 5 to 6 men roping, and then only 234 reindeer were handled. In another case during the winter a herd was held in a corral during severe weather and starved for 48 hours. When to this period the collecting and driving of the herd is added it can be readily seen that much injury must have resulted to the animals.

If reindeer are handled in too small an inclosure, the warmth of their bodies soon causes the surface of the ground to thaw and this later freezes and becomes icy, resulting in many injuries to the animals from slipping and falling. If there are sticks and stumps projecting through the snow, as is frequently the case, ribs and legs are sometimes broken. When the corral is too small some of the animals may be trampled, and this results in many losses. In the second case mentioned above, of 1,443 deer handled during the 48-hour period, 11 deer were accidentally killed and a great many injured. Under present methods the owners regard these losses as an unavoidable part of a round-up. With proper corrals, however, such losses may be almost entirely prevented.

A diagram of a highly successful type of corral in use at Buckland River, Alaska, for overcoming the present drawbacks in handling, is shown in Figure 2. In a corral of this type used in the Kotzebue Sound district during the marking season of 1921, a large herd was put through in 10½ hours and a total of 1,680 fawns marked. In another case, at Golovin, 1,250 animals were marked (ears notched and buttoned) in 14¾ hours. The corral illustrated is exceptionally large, being made to hold 10,000 reindeer. A corral of about half this capacity should suffice for the average Alaskan herd.

The separating pens, or pockets, on either side of the entrance to the connecting chute form a special feature of this type of corral. By their use sections of a milling herd may be detached and put through the chute as needed. The pockets are merely partitioned off from the corral by "hooks," made in three sections at angles, which keep the detached part of the herd from rejoining the others, by turning the leaders away from the entrance, so that the animals mill in the pocket until the excitement due to imprisonment has subsided. Without the hooks it would be almost impossible to handle the last animals in the corral and the leaders would become wild and refuse

to be driven. Two hooks are employed, for the reason that the milling animals tend to reverse the direction of their movements when they approach a pocket from which they have succeeded in escaping on previous occasions, and then, not recognizing the danger of entering the other, they are driven into it and operations are thus facilitated.



B1924M

FIG. 2.—Diagram of improved type of corral for handling reindeer, chiefly for counting and branding; constructed entirely of split poles. The reindeer are driven into the main corral between long side wings, and sections of the herd are detached as needed by means of the separating pens, gates, and chute. A further improvement would consist of a small corral at the end of the chute, where all animals are handled, to trap any that might evade the herders stationed at the swing gate.

Men are stationed at the various platforms and gates, two on the platform at the end of the chute (Pl. XVII, Fig. 2), to hold back the reindeer by catching their horns, in order to prevent overcrowding at the exit. The chief herder is usually the one stationed at the swing gate, and he decides what disposition is to be made of each animal as it passes.

As a rule the Lapps build the corral just over the brow of a hill, so that the reindeer do not see it until they are practically inside. The animals are driven in through the entrance driveway between long wing fences, which in some cases extend out a quarter of a mile or more on each side. (Pl. XVI, Fig. 2.)

The present slow system of corralling often results in keeping a herd in the immediate vicinity of the corral for long periods, in some cases for weeks at a time. This causes undue trampling and damage to the near-by range and exposes the animals to grazing on contaminated ground, where they pick up large numbers of parasites, and further emphasizes the need for improvement. If for unavoidable reasons the improvement advocated can not be made at once, the herd should always be driven to the corral by the same route, in order to limit as much as possible the damage to the range and the danger of parasitic infection. Furthermore, when liberated the animals should not be allowed to remain about the corral, but should be driven away at once to fresh feed.

Choice of site and selection of building material are two important considerations in constructing the main corral on the summer range. It is particularly important to build the corral in a dry place, as it is readily apparent that a herd may be handled more efficiently and with less danger of injury here than on wet ground. When the corral is on wet ground, the tramping of the "milling" animals soon converts it into a dangerous mud hole. The best sites along the coast are on sandy spits immediately adjoining the beach.

In the selection of building material, it should be kept in mind that a closely constructed corral fence or wall is preferable to an open one. There is the possibility of considerable injury to animals in an openly constructed corral. When pushed and frightened, reindeer often try to break out of the inclosure at any point they can readily see through; and, in the attempt, may get their legs or horns caught and, as often happens, broken. Consequently a closely built split-pole or board corral is preferable to one constructed of wire or of open paneling.

METHOD OF ROPING.

The lasso, or lariat, used in Alaska differs from the rope commonly seen in the Western States. Reindeer men prefer a flexible cotton rope about one-fourth inch in diameter. The eye is made from a piece of reindeer horn, and is of considerable weight. The entire

FIG. 1.—ROPING REINDEER IN WINTER CORRAL. B22602

Herds may be handled successfully even in cold weather. This photograph made on January 10, 1921, when the thermometer was between 30° and 40° (F.) below zero.

FIG. 2.—END OF CHUTE LEADING OUT OF CORRAL. B1901M

The walls are 7 feet high, and 5 feet apart at the top. The floor space narrows toward the exit, until it is only 1 foot wide (see diagram in text, Figure 2). Under this method of construction crowding of reindeer trying to escape can be prevented by herders stationed on either side to hold them back by catching their horns.

rope is gathered up into a number of small coils, and thrown at the deer's antlers with the motion used in throwing a stone. The roper does not whirl a single loop and throw the rope in cowboy fashion, but throws the lasso so that it hits the horns and entangles them. The thrower does not know whether he will catch one or both horns, but expects that the loops will get caught on one or more of the numerous points on the antlers. Roping reindeer (Pl. XVII, Fig. 1) is much easier than roping cattle or horses, where either the feet or head must be accurately encircled. Reindeer are caught by the feet only by accident.

A form of injury that often occurs in roping, but to which the reindeer owners appear to pay little attention, is to the growing horns. These are very vascular and soft, and are easily hurt. Serious hemorrhages are apt to occur, and harmful bacteria may gain entrance where the velvet of the horns has been rubbed or torn off. For this reason it is desirable to avoid roping the older animals, at least, until the velvet has "set."

EAR MARKING.

Ownership in reindeer is commonly indicated by ear marking. Usually this is done by cutting off the tip or notching one or both ears, and one or two herd owners use a metal ear tag or button in addition to cutting. Each individual owner has a different earmark, and often separate marks are used among the various members of the same family, particularly in the case of the Eskimos—the father, the mother, the sons, and the daughters each having his or her individual mark. Constant trading and bartering of deer among the natives results in the earmarks being continually so changed that at times the ears are almost entirely cut off. Moreover, in the absence of provision for the registry of these marks, there is often considerable confusion as to the ownership of the animals, and petty "rustling" is frequently reported.

The fawns in the majority of herds in Alaska are now earmarked like their mothers. Individual reindeer owners pick each fawn as belonging to this or that mother and mark it accordingly. In a small herd this may be successfully done, but in a large community herd, especially where there are many owners, marking according to the mothers does not work out very well. In a "milling" herd especially, fawns may not follow their mothers. Thus it may often be only a guess as to ownership in the picking of any particular fawn, and a large margin of uncertainty must exist in the selections made. Consequently, there is the possibility of injustice in marking, particularly in the native herds, since it is evident that the individual owner having the greatest assurance and aggressiveness is in a position to get more than his share of fawns.

The solution is to adopt the plan of cooperative herds proposed by the Bureau of Education, each under a single brand, in which the owner has a percentage holding. Under this arrangement each owner will be given his pro rata share of the total fawn crop, based on the total number of his does in the herd; and the burden of loss and expense of running the herd, as well as the increase, will be proportionately divided among all the owners.

Marking all fawns alike in a herd under the percentage ownership system is to the best interests of the herd. Marking fawns according to the mother involves the use of the old roping method and handling the herd in a corral for long periods, resulting usually in injury to the animals. On the other hand, marking by percentage involves the use of the chute instead of roping, and, in addition to speeding up operations, insures good results and largely eliminates injury.

BRANDING.

Trimming or notching the ears of a reindeer is unsatisfactory as a means of identification, and, as previously mentioned, such a mark may be altered with comparative ease. A brand on the skin, being less easily changed, is preferable. To try out this method, two yearlings were branded on April 30, 1921, at the Unalakleet station, with a hot iron, one on the jaw and the other on the hip. The hair was clipped, and the brand in the form of a U was applied lightly. The lesions healed rapidly and the hair began to grow very soon. In August of the same year, when the animals were brought back to the station from summer grazing, it was found that the jaw brand had been a complete success, a clear white U being plainly visible (Pl. XVIII, Fig. 1). The brand applied to the hip did not show quite so plainly, but was a sufficient mark for practical purposes.

Fourteen other animals were branded during the month of August, 1921, for later observation. These were all branded on the hip, since this promises to be the best location for branding for easy observation when the animals are on the range or are being driven. In these cases the hair was not clipped. In one or two instances, owing to the heavy growth of hair, the brand did not come quite clear and had to be retouched. This, of course, is bad practice. With a little more experience it is felt certain that the brand can be applied successfully at one operation.

Previous attempts at branding in Alaska had not been successful, probably because too much force was used in applying the iron, thus driving it through the skin. Some animals are reported to have died following the operation. Reindeer skin, as is the case with all heavily coated animals, is very soft and thin, and consequently branding must be done deliberately and carefully.

DEHORNING.

It has been remarked that the large growth of horn which is common to all reindeer must be a heavy drain on the system, and that if the horns could be eliminated the body weight of the animal might increase. Experiments in dehorning were made on two yearling reindeer which were being kept at the Unalakleet station. About 10 days after the horns had dropped the velvet had grown to a width of about one-fourth inch surrounding the horn core. After slightly moistening, sodium hydrate was rubbed onto this new growth. Only one of the horns on each animal was treated. Growth stopped at once and a scab covered the area. In about three weeks the scab began to lift at one corner and in a few days the treated horn was growing just as rapidly as the untreated one. That considerable injury had been done to the horn was evinced by the fact that a large white area appeared on the velvet. Strange to say, the injury appeared to stimulate the growth as well, and by the latter part of August it was found that the treated horn was much larger than the untreated one. (This is illustrated in Pl. XVIII, Fig. 2.) It had been suggested that the proper time to conduct a dehorning experiment is when the fawns are newly born; but unfortunately, it is not safe to handle the fawns at that time; consequently the outlook as regards dehorning does not seem promising.

CASTRATION.

The Lapp method of castration, which consists of crushing the testicles, was introduced into Alaska at the time the reindeer were first imported. This method, still followed in some districts, is barbarous and often ineffective and should be stopped as soon as possible. The method used for other kinds of domesticated stock, consisting in opening the scrotum, or bag, with a knife, severing the cord, and removing the testicles, is proper for reindeer as well.

No instruments other than the knife are required if the operation is done on the fawn soon after birth, but this is not good practice. With the older animals, however, serious hemorrhage is apt to follow unless an instrument such as the emasculator is used to sever the cord. It is gratifying to record the fact that the use of the emasculator by the Biological Survey in 1921 was at once accepted by herd owners as an improvement and that its use has spread rapidly. Not only are the natives using it under the direction of officials of the Bureau of Education, but the leading Lapps have expressed themselves as in favor of the method. During the past season a large number of animals in most of the principal herds have been successfully castrated with the emasculator, so that it is now probably only a question of time until all herd owners will have adopted its use.

The time for castration should be governed by the weather, as it is unwise to undertake it when the weather is hot and flies are abundant. The proper time to operate on fawns or yearlings is when green food is available and before the hot weather and the flies appear. As it is unsafe to rope or handle adult reindeer when the horns are in the velvet, on account of danger of injury, castration of the older animals should take place either early in the spring before the horns are grown, although they are harder to handle at this time, or else after the velvet has "set," which is just before rutting, or about August 20.

Cleanliness in the operation is important to avoid infection, and disinfectants should be used to keep the hands and the instruments clean. The operator should not have to handle the animals, but they should be thrown and held as he directs.

FAWNING.

The average period of gestation in reindeer is 7 months and 7 days, so that the first fawns generally appear about April 10. In 1920 and 1921 the first signs of rutting were noticed the latter part of August, and it continued into October (Pl. XIX, Fig. 1). During rutting time the herd should be placed in the best pasture available and should be very little disturbed, and during the latter part of the winter the does should be kept as quiet as possible for at least two months before fawning, in order to avoid accidents.

In selecting areas to be used by reindeer during the fawning period, at least two requirements must be borne in mind, namely, ample green feed, so that the does will produce sufficient milk for the fawns, and a site giving protection against severe storms. A good fawning range should have as good natural protection as the topography and surface cover will allow, particularly in the way of coves and hollows and available patches of protecting brush or timber. Low altitudes with favorable exposures for the early growth of vegetation afford the most desirable fawning grounds.

Along the coast of Alaska fawning usually takes place on some portion of the summer range, either on exposed flats immediately along the beach or on the south slopes of the low hills adjoining it. The snow leaves these areas earliest, exposing patches of bare tundra, where the first fresh growth appears, thus making available the succulent green feed necessary for the does during fawning (Pl. XIX, Fig. 2). This early growth usually consists of young shoots or flowering stalks of the small cotton sedge (*Eriophorum callitrix*) which appear abundantly on the tundra, and its green blades also are found here and there on protected spots.

A definite fawning ground should be established and used on each reindeer allotment, both from the standpoint of best care of

FIG. 1.—REINDEER BRANDED ON JAW WITH A "U."

A means of marking reindeer is much needed to take the place of the present practice, which frequently results in badly mutilated ears. Branding is still in the experimental stage, but the success of the few experiments is most encouraging.

B22715

FIG. 2.—A DEHORNING EXPERIMENT.

One horn of the animal pictured was treated with caustic about four months before to try and arrest its growth. A white patch in the velvet shows that some injury was done to the horn cells, but the caustic also stimulated their growth. The treated horn became much larger than the untreated one, which can be seen on the opposite side. The outlook for dehorning reindeer is not promising.

B22748

FIG. 1.—RUTTING REINDEER BUCK.

The flashing eye, thickened neck, line along flanks, and manner of holding head to one side are characteristic. The bucks look more dangerous than they really are, though they often fight among themselves.

B20521

FIG. 2.—REINDEER DOE AND FAWN.

The mother is licking her newly born offspring, which lies in the snow. The fawns are very hardy from the first and very few die at fawning time. They are able to follow their mother immediately after birth. (Photograph by Lomen.)

the range and best results with the animals. Under present methods, in addition to being used as fawning ground in spring, the range is often grazed continually during the summer season, and this subjects it to becoming depleted through over-utilization. Setting aside a separate area for use only during fawning would insure a forage crop each spring and plenty of the best available fresh green food for the does at the time.

The practice of weaning fawns is not followed in Alaska, and many of them are still being suckled when the next fawn arrives. This is not only a double drain on the doe, but also is detrimental to the new fawn. Consequently herd owners should separate yearlings, along with bucks and steers, from the does prior to fawning. One Alaskan owner has already put this into effect. It is an old Lapp practice which was discontinued by them when they came to Alaska and should be revived.

FEEDING EXPERIMENTS.

Feeding reindeer has been tried out on a small scale. In 1920 two fawns were brought to the Unalakleet station and kept inside a small yard and shed for a period of six months. During this time they were fed the following: Reindeer moss, 3,000 pounds; wild native hay, 1,500 pounds; and assorted meal, 200 pounds. The meal, which was such as could be purchased at any village store, consisted of rolled oats, cornmeal, oatmeal, farina, graham flour, wheat flour, and hominy. The only item on this list which the fawns refused to eat was the hominy, which was apparently too hard for their teeth, and after attempting to crack the kernels a few times, they gave it up. In addition, apple and potato peelings and similar scraps were fed and much relished by the animals. The above test indicates that reindeer may be housed and domesticated like other animals, although the pair experimented with were not kept entirely away from reindeer moss.

Reindeer are not careful feeders like the horse. They resemble cattle in this respect and do not object to food which has been handled or, in some cases, even trampled. There is little difficulty, therefore, in getting them accustomed to a new food. They may refuse it at first if it looks or smells strange, but this can be overcome by forcibly placing some of it in their mouths, and if it is found palatable they will soon take it freely.

Reindeer respond promptly to a good food supply. A correspondent on the lower Yukon acquired a herd which had been badly managed, and the animals were in very poor physical condition. He put them on good pasture, and though they improved to some extent, the average dressed weight of the steers was only 150 pounds

for the first season. The second year, however, showed a marked improvement, and the dressed weight rose to from 175 to 200 pounds.

Another instance might be cited of a herd on Norton Sound. In 1920, through too much close herding and corralling, a herd had run down to such a point that some of the animals were dying from parasitism, which always follows prolonged close herding. The dressed weight of steers ran very little over 150 pounds, though few weights were taken. It was recommended to the owners that they change their system so that the reindeer would have more freedom and an opportunity for fresh pasturage. The result was apparent in one summer, and in 1921 the animals which were killed for meat were in splendid condition; one weighed 204 pounds, two 199, and another 156. In each case the skin, head, and legs had been removed. From the above it is evident that reindeer need only good range and careful handling greatly to increase the returns in yield of meat.

For centuries the Lapps have been driving reindeer and feeding them on moss alone and during recent years in Alaska this has also been done. The practice in use heretofore has been to drive the animals until they show signs of exhaustion and then turn them loose and take fresh ones. This does not appear to be good practice, as a sled deer is a comparatively long-lived animal and deserving of better treatment. No animal can be expected to perform steady and arduous work on poor food. It can be predicted with confidence that if reindeer were given grain in some form together with the moss, they would endure far more hardship without losing so much flesh and strength. Further experiments are necessary to settle these points fully and to determine the facts as to the possible use of the reindeer as a light draft animal.

BREAKING SLED REINDEER.

Breaking reindeer for driving, as observed in the Unalakleet district, is done in the winter and the method is rather crude and rough. A reindeer is roped, haltered, half dragged and half driven to a tree or post and tied there. It is usually left tied for a couple of days, until it is sufficiently starved to follow a man. Then it is led to a moss patch and tethered with a long rope. When first harnessed, the deer is tied short, so that it can not strike with its fore feet. Long lines are attached to the halter for driving, and at first the Lapps let the deer drag them about on skis. Sometimes they hitch the animal to a log, and finally it is harnessed to a sled by a long single rope.

The driver starts off by letting the animal gallop as fast as it can, and by jerking one rein or the other a course is steered. An animal soon becomes exhausted and lies down; then it rises and starts off rapidly, but after a short course it becomes exhausted once more.

When the driver thinks it has had enough he tethers it out again for feed and rest.

As reindeer get no other food than moss when they are being worked, their strength soon diminishes, and it is the opinion that they do no more and no less, comparatively, than an ox would do under similar conditions if fed on nothing but hay. Well-broken animals are not very plentiful in Alaska, and many reindeer men prefer to drive dogs.

Many difficulties are encountered in using reindeer for sled animals, and one especially is through meeting dog teams on the trail. In the Unalakleet district only the Lapps drive reindeer (Pl. XX, Fig. 1), while the Eskimos invariably use dogs. Almost everyone who has driven reindeer has had fights with dogs or has had his deer bitten or killed.

Added to this menace is the difficulty of finding moss within convenient reach of the villages, where the deer may be tethered. The most satisfactory and safe procedure under present conditions is to house reindeer at the end of a journey and have available moss for feeding which has been gathered beforehand. It is believed that grain should be added to the moss ration. Well-broken reindeer with good manners, that is to say, reindeer fit for a woman to drive, are uncommon. It is believed, however, that with the more general adoption of improved methods of castration, gentle animals will become more common.

On a few trips made by us with Lapps behind sled reindeer it was noticed that most of the animals used were timid and easily frightened. They would jump off the trail for very little cause. Thereupon both reins would slip over to one side and the animal would stop, facing the driver. To make another start, after the animal had been headed in the right direction, one line was slipped over the back until it was over the root of the tail, when the deer would start off again, perhaps in the right direction. It must be said, however, in all fairness to reindeer, that some of them are gentle and drive well, and this indicates that much more could be done with them than is generally being accomplished at the present time.

The sleds used by the Lapp are not altogether satisfactory. They are so narrow that unless the driver sits with one leg on either side to keep it in an upright position it is very apt to turn over. The Lapp sled has been developed no doubt to travel over rough country where there are no trails, but it is not the best for use in those portions of Alaska where good trails are to be found.

PACKING AND RIDING.

Prospectors occasionally make use of reindeer as pack animals during the summer (Pl. XX, Fig. 3). In cruising about in the hills reindeer are preferable to horses in many respects. They need no

fodder except what they pick up as they go along; they can traverse boggy ground in which a horse would mire; their feet do not have to be shod; and, finally, when they are no longer required for packing they may be slaughtered for food. It is surprising that so little use has been made in Alaska of the reindeer as a pack animal. Doubtless the principal reason is that few animals are broken for this purpose and that little effort has been made to supply the demand.

As regards the weight that a full grown reindeer may support on its back, the reader's attention is called to Plate XX, Figure 2, in which a heavy man is seen astride a reindeer. In Siberia Bertholf saw Tungusic reindeer commonly used as riding animals; he says that some of them are capable of supporting a 200-pound man.

PREDATORY ANIMAL ENEMIES.

The predatory animals that attack reindeer in Alaska are chiefly bears, wolves, lynxes, wolverenes, and eagles. Their depredations are greater in the interior than on the coast, but while important they are not extensive. Bears are the most numerous and destructive enemy. Only a relatively few wolves, lynxes, and wolverenes now remain along the coasts of Bering Sea or the Arctic Ocean; consequently the losses from predatory animals there are comparatively small, but in the interior they become more of a factor. Eagles are largely in the interior and are especially destructive to fawns. It is reported that in Lapland the herders must stay continuously with their reindeer during the night to ward off depredations by wolves, but on the ranges used in Alaska up to this time night herding to keep off predatory animals is rarely necessary.

INJURIES AND DISEASES OF REINDEER.

Reindeer have generally been considered to be very healthy animals, and though our observations substantiate this to a great extent, there are many minor ailments and parasitic diseases which are taking their toll from the herds. No serious epizootic or contagious diseases have been encountered. In Europe it is said that epizootics ravage the herds occasionally, but in Alaska there are no records of any large numbers of reindeer dying suddenly. The deaths which do occur come one or two at a time, and the herds have their ups and downs like cattle or sheep.

In the following paragraphs the diseases will be dealt with under separate heads; treatment and methods of prevention are indicated wherever possible. It will be noticed that some stress has been laid on the slaughter of all animals likely to convey disease to others. Isolation might be equally effective in some cases, but can not be recommended, as there are no facilities at the reindeer camps for such

FIG. 1.—SLED REINDEER.

Most winter freighting and travel in Alaska is still done with dogs, but reindeer are used to some extent on the Seward Peninsula and northward. Sled reindeer travel on roads from 20 to 35 miles a day. (Photograph by Lomen.)

FIG. 2.—RIDING REINDEER.

In parts of Siberia reindeer are used for both riding and pack animals. In Alaska, as the above picture shows (from Seward Peninsula), some reindeer are big and strong enough to support a man, but they are nowhere used for riding. (Photograph by Lomen.)

B1926M

FIG. 3.—PACKING REINDEER SOUTH OF THE YUKON.

The prospector has occasionally found reindeer useful as pack animals in summer. At the journey's end the animals may be slaughtered for food. (Photograph by Schneirla.)

B22618

FIG. 1.—FAWN INJURED BY TRAMPLING.

A large piece of skin was torn off the back in the trampling of animals in the corral. The fawn had to be killed.

FIG. 2.—LONG HOOF.

This disease causes overgrowth of horn with malformation, resulting in a crippled condition of the animal.

purposes. An improvement which large reindeer owners might profitably undertake would be to provide paddocks or stabling for injured and sick animals. The present policy is to raise the standard of the Alaska herds; therefore, no sickly or undersized animals should be kept, and this applies especially to breeding stock.

ACCIDENTS.

Accidents are of common occurrence when herds are being handled in the corrals (Pl. XXI, Fig. 1). A suggestion which reindeer owners could well follow would be to isolate all the injury cases as soon as they occur to prevent further damage to them from trampling by the other animals. If there is no time to attend to injured reindeer while handling of the herd is in progress, they should be left by themselves in some inclosure provided for the purpose until such time as they may be properly looked after. In many cases it will be found advisable to slaughter and dress the most seriously injured animals. In other cases, where treatment seems likely to help, the animal might be treated and then turned out with the herd or fed by hand for a few days. Following this simple suggestion would in many cases be found profitable to reindeer owners. Heretofore, diseased or injured animals have been turned out on the range, without any attention, to live or die, as the case may be.

BROKEN HORNS.

Fawns frequently break their horns when being roped in the corral, especially when they are in the velvet at marking time. These accidents may be eliminated to a great extent by avoidance of overcrowding in the corral and by careful handling. Small wire inclosures are dangerous for fawns when the strands of wire are so far apart that their horns get caught. The older animals also suffer in this regard, and while they may not break their horns, they may be injured otherwise. When a fawn breaks its horn the pedunculated portion of attachment to the skull usually breaks with it. The broken horn must be removed, together with the piece of skull. Care must be taken not to leave a pocket of skin over the exposed part of the brain where pus will find a lodgment. The skin should be trimmed in such a way that it will just cover the opening.

Many fawns die as the result of broken horns. At one round-up 31 fawns suffered the loss of one or both horns. In this case they were killed and dressed, since the owners had found by experience that animals usually die as a result of such injury. In another case, of a total of 550 fawns marked, 73 lost one or both horns. When the horns break without damaging the skull there is an excellent chance for recovery, but if the brain is exposed, unless proper surgical methods are adopted, recovery is doubtful.

BROKEN BONES.

Broken bones are of common occurrence at round-ups, especially at marking time. Rough handling is responsible for most of these breakages. Native herders particularly should be cautioned against injuring the animals that are being marked. A heavy man can easily crush in two or three ribs when he is throwing a fawn on the ground, and legs at times have been heard to snap. Needless to say, severely injured animals should be killed as speedily as possible.

LONG HOOF.

Without entering into a discussion on the probable causes of long hoofs (Pl. XXI, Fig. 2), which are still under investigation, it seems advisable to urge reindeer owners to pay more attention to this overgrowth and to trim and pare the long hoofs so that the deer will be able to walk squarely on their feet. It has been noticed that many cases of lameness in the herds are attributed to this condition; the long hoofs have been left untrimmed, causing the animals to walk on their heels, and ending in the formation of sores. These sores resemble those seen in foot rot. In an affected herd timely attention to the feet would certainly cut down the losses.

FOOT ROT.

All foot troubles are serious when they occur in grazing animals; for as soon as the animal has difficulty in walking it can not feed properly and soon becomes thin and worthless. If the lameness is severe and likely to become worse it is the best policy to destroy the animal. The benefit in this case is twofold; first, if the animal is in good flesh the meat can be used and, secondly, the risk of passing on the disease is eliminated. Foot rot and dermatitis are among the most troublesome of reindeer diseases. The percentage of lame animals in a herd may be considerable. The treatment of advanced cases is hopeless under present conditions where the sores can not be attended to every day.

The most likely method of stopping the spread of the disease would be as follows: On the appearance of the first few cases, segregate or kill the sick animals and collect the healthy ones and drive them through a shallow trough containing a 5 per cent solution of one of the recognized sheep dips. The dipping should be repeated every second or third day. At least one herd owner in Alaska has made preparation to follow out this plan in its entirety. The Lapps have known, probably for centuries, that one way of getting rid of the disease is to drive their herds to a new ground. This is a practical method, as the sick and lame animals were thus left behind and consequently contagion in the herd diminished.

DERMATITIS AND ABSCESSES CAUSED BY WARBLE GRUBS.

During the fly season in July and August, serious cases of dermatitis may often occur (Pl. XXII, Fig. 1). In one herd of about 2,000 animals fully 25 cases were seen. The lesions are most frequently on the hind legs above the hock, but they may also be seen on other parts of the body, such as the stifle, hock, knee, forearm, fetlocks, and shoulder, the frequency being in the order named. Swelling is the first symptom, followed by the death and exfoliation of the skin. The animals feel irritation and bite the affected parts. After the skin has peeled off, large sores are seen, which may attain 6 to 8 inches in diameter. The surface of the wound may be covered with round, raised granulations; in other cases the flesh dies. The sores are evil smelling and are covered with sticky green pus (*Bacillus pyocyaneus*). The fawns and yearlings are the worst sufferers. There are many cases, however, which do not progress as unfavorably as those described above. Many animals have been noticed bearing small lesions and patches of skin denuded of hair. These spots are undoubtedly the result of irritation, and the hair has been nibbled off. According to the Lapps, dermatitis is seen more often during the hot dry summers than in wet seasons, and is most frequent with close-herded animals.

All the evidence obtained pointed to flies as the probable cause of the trouble. Accordingly the skin covering the lesions was carefully examined and numerous eggshells of the warble fly *Oedemagena tarandi* were found. The lesions occur where most of the eggs are deposited, and as it is already known that after the eggs hatch the young larvae bore through the skin, these were also looked for in the sores. Numerous larvae were encountered and it was noted that inflammatory tracts followed them and that they acted as disseminators of the pus, thus enlarging the affected area. It seems clear that the larvae when boring through the skin, drag in the bacteria which happen to be lying upon it. The larvae themselves occasion some swelling and irritation, which favors the development of the bacteria. In view of the fact that cattle suffer similar effects from the penetration of the warble larvae (though in much less severe form), there is no doubt that this evil must be laid at the door of the reindeer warble fly.

The treatment for dermatitis is surgical. All dead tissue must be removed and the wounds dressed with antiseptic solution, either lysol or sulphate of copper being excellent. If the lesions are large or if the joints are involved, the animal must be killed. There is little hope of prevention until means are found for controlling warble flies. But as frequent corralling of animals and close herding during the hot weather expose the reindeer to fly attack, such

practices should be avoided as much as possible. The mortality in some herds may run as high as 1 to 2 per cent.

In one small herd of 700 animals, 9 affected fawns were examined, 5 animals were operated on and released, and 4 were killed on account of the involvement of the hock joints. In another herd of 1,300 reindeer it was learned that 6 fawns had been killed for a similar cause. The strains of *Bacillus pyocyaneus* brought back from Alaska were tested on guinea pigs in the Pathological Division of the Bureau of Animal Industry, where it was found that 0.5 cubic centimeter of a broth culture inoculated intraperitoneally was fatal to guinea pigs in 1 to 4 days.

EYE TROUBLE (KERATITIS).

Inflamed eyes are not of uncommon occurrence. The condition may become aggravated and end in blindness (Pl. XXIII, Fig. 1). It is rare that both eyes are affected, and in only one or two instances were totally blind animals encountered. In one particular case, in a herd of about 3,000 reindeer, approximately 1 per cent of the animals were affected, only one of them being blind in both eyes. The affection seems to be seasonal, starting with the hot weather and disappearing in the autumn. Though the cause of the disease has not yet been ascertained, it would appear to be infectious, and therefore the diseased animals should be slaughtered and not kept as breeding stock. Treatment of the eyes would be valuable if there is any way of doing it regularly. Nitrate of silver solution promises to be the most satisfactory remedy.

WARTS (PAPILLOMA).

Warts seem to be more common in reindeer than in either cattle or sheep, and they often attain large size. While most frequently noticed on the flanks, they may be found on all parts of the body, and are generally black in color, with a narrow neck at the point of attachment. In some of the herds these warts were very noticeable. They appear in the spring and often disappear when the cold weather starts. In the light of recent investigations, it seems possible that they are produced or stimulated by parasites. It does not seem as though much importance need be attached to these growths, but they have attracted the attention of some of the herd owners.

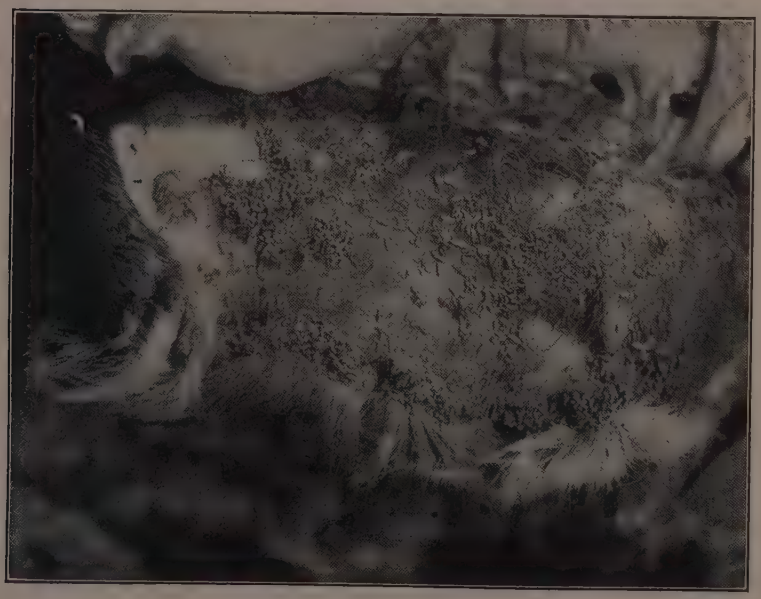
RHEUMATISM.

Rheumatism has been observed in old deer. In life the affected animals show a marked stiffness and a disinclination to move. On post mortem examination roughenings and exostoses of the bones were found, also reddened and turbid synovia in the articulations.

B22709

FIG. 1.—DERMATITIS IN REINDEER FAWN.

This condition follows the penetration of larvae of the warble fly (*Oedemagena tarandi*).



B22654

FIG. 2.—SCREW WORMS (PHORMIA TERRAE-NOVAE) ON REINDEER SKIN.

Infestation is common at the time of year when warble grubs are leaving the backs. When infested with a large number the animal usually dies, hence the necessity for following the methods advocated for prevention.

B1927M

FIG. 1.—EYE DISEASE OF REINDEER.

Blind fawn. This is a summer disease, probably carried by flies, causing permanent blindness, but usually affecting only one eye.

B1928M

FIG. 2.—RICKETY 2-YEAR-OLD DOE.

Animals in this condition should be killed and not allowed to breed.

RICKETS.

Rickety conditions are rare in reindeer (Pl. XXIII, Fig. 2). While only occasional cases may be seen, the fact that reindeer crave lime salts at certain times of the year indicates that their systems lack some essential requirement in mineral matter. Toward the end of winter it has been observed that they nibble at each other's horns, and short, stubby, chewed horns may be seen, especially on the fawns. Does may also be found in this condition, their horns having been gnawed off close up to the head. The horns disappear from the range soon after they are shed. Reindeer may injure themselves by trying to swallow too large pieces of bone. In two instances animals were found with pieces wedged tightly beside the molars. Dr. F. H. Gambell, in 1904, on St. Lawrence Island, noted that they showed craving for calcium salts.[14] In some districts it may eventually be found necessary and profitable to feed bone meal.

PARASITES.

Parasites appear to be the worst enemies the reindeer have. They fall into two classes, being both internal and external. The internal parasites will be considered first.

TAPEWORMS.

Tapeworm cysts.—Three forms of tapeworm cysts are found in reindeer, and all three are conveyed by dogs. The dog is the host of the tapeworm and the reindeer is the intermediate host. That no misunderstanding may exist, the three forms will be described separately.

Taenia hydatigena (*T. marginata*) is a common tapeworm in dogs. The mature segments or joints of this worm containing the ripe eggs of microscopic size are passed in the feces of the dog, and are picked up by the reindeer with their grass or other food. The eggs hatch and the young larvae find their way into the body cavity. The liver is generally the organ most affected, and frequently 10 or 12 cysts will be noticed just under the covering. They may also be found in the fatty tissues round about the intestines. The cysts have the appearance of small bladders filled with clear fluid. The bladder worm, as it is called in this state (*Cysticercus tenuicollis*), consists of a head, neck, and bladder. If a dog is fed on raw offal containing these bladder worms he will soon develop tapeworms, and the more raw offal he gets the more tapeworms he is likely to have. The damage caused by these bladder worms in reindeer is confined principally to the liver, which, because of the parasites, is often ren-

[14] See Georgeson, C. C., Reindeer and caribou: Bur. Animal Ind., Circ. 55, U. S. Dept. Agr., pp. 377–390, 1904.

dered objectionable for use as food. Cooking destroys the vitality of the cysts and they are then harmless to dogs.

Taenia echinococcus[15] is a small tapeworm, also a parasite of the dog, and its intermediate form, which is commonly found in reindeer, consists of watery bladders or cysts, generally occurring in the lungs. The cysts are small at first, but gradually enlarge and often attain the size of an orange. Echinococcus cysts persist for years and may kill their host. Reindeer obtain the cysts by swallowing the eggs which are passed by dogs, and dogs obtain the tapeworm by eating raw reindeer meat or viscera containing the cysts. This circle may be broken by treating the dogs with worm medicines and by not feeding them raw meat or offal.

Taenia krabbei also inhabits the intestines of the dog, and its intermediate cystic form, *Cysticercus krabbei*, is unfortunately very common in reindeer. The cysts occur in the muscular tissues and are easily seen, especially in the deep muscles of the quarters. They are small egg-shaped bladders with a white spot showing in the center. Meat in which the cysts are numerous is considered objectionable for use as food.

At least one herd in Alaska seems to be free from the three forms of cysticerci mentioned above. This is on St. Lawrence Island. When reindeer were first introduced on the island, 1902–6, no reindeer dogs accompanied them, and since that time herd dogs have never been used. This fact explains their freedom from cysts. Sled dogs are in use on the island, but they do not come into contact with the reindeer.[16]

Prevention of tapeworms in dogs.—In view of the fact that reindeer obtain three of their worst parasites from dogs, every effort should be made on the part of reindeer owners and others to rid their dogs of tapeworms. Reindeer dogs are undoubtedly the worst offenders. In the first 25 dogs treated for tapeworms it was found that every one harbored the parasites. Sled dogs do not carry so many worms, which is to be expected, as the diet of working dogs consists chiefly of dried salmon and other fish. Of the first 24 malamute sled dogs which were treated only 6 passed worms.

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[15] Man as well as reindeer may contract echinococcus cysts by swallowing the eggs of the dog tapeworm, *Taenia echinococcus*.

[16] In an unpublished report made by E. C. Joss, veterinary inspector, Bureau of Animal Industry, 1914, some interesting observations on cysticerci in reindeer are recorded. Joss spent a month in Alaska and made a number of post-mortem examinations of reindeer. He found both *Cysticercus tenuicollis* and *C. krabbei*, and also reported *Taenia echinococcus* in dogs. *C. krabbei* cysts were encountered in the heart muscles in several cases and were also recorded in the cheek and other muscles. Joss treated a number of dogs with tapeworm remedies and obtained many tapeworms, which are now in the collection of the Zoological Division. This note is made through the courtesy of Dr. B. H. Ransom, of the Bureau of Animal Industry, whose advice and assistance have been invaluable in connection with working out the parasites of reindeer.

The form of treatment which was used is based on that recommended by the United States Bureau of Animal Industry and is as follows: The dog should be fasted for 12 hours. It is then given 3 cubic centimeters, or three-fourths teaspoonful of oleoresin male fern in 2 ounces of warm milk. This dose was found satisfactory for sled dogs of ordinary size. The dog's head must be firmly held and the medicine poured slowly into the pouch at the side of the mouth. The medicine will run between the closed teeth, and the dog's jaws need not be separated. As soon as the medicine has been swallowed the dog's head should be tied for a period of three-quarters of an hour so that it can not lower it to vomit, after which a dose of nut areca is administered. This dose consists of 3 grams, or about a level teaspoonful, of freshly ground nut areca diluted with 2 ounces of milk. The dog's head is again kept tied for about half an hour. The dog should be kept chained until it has passed the worms, which must be collected and burned. These directions have been followed by a number of dog owners in Alaska and the reports received have been favorable throughout.

Reindeer tapeworms.—Two species of tapeworm have been found in reindeer. One, a species of Moniezia, has been collected in six different herds. The other worm is evidently rarer and has only been found once. The tapeworms often attain a length of 10 feet or over and as many as nine have been taken from a single fawn. When the worms are numerous the fawns must necessarily be adversely affected. Unfortunately, no satisfactory method of prevention has been developed so far, since the life history of the worm is unknown. However, it has been noticed that the worms are more numerous in closely herded animals, which is an indication that the old grazing grounds are the most heavily infested. These tapeworms seem to attack young animals almost exclusively, and in only one instance were they encountered in an adult.

LUNG WORMS (DICTYOCAULUS Sp.).

Lung worms, as their name implies, are to be found in the lungs. In bad cases the air tubes may be filled with tangled skeins of worms. Paroxysms of coughing occur and the deer often project masses of mucus several feet in front of them. Usually, however, the coughed-up mucus is swallowed, and the worm eggs which are contained in it are passed through the alimentary canal with the droppings. Broncho-pneumonia is associated with lung worms. The adult worms were found in the 2-year-old reindeer and also in some cases in old animals, where they were collected in great numbers. The eggs of lung worms hatch as a rule in the lungs, or if they are coughed up, they hatch outside the body on the ground and are thus passed on to other animals, which pick them up while grazing.

ROUNDWORMS IN THE STOMACH AND INTESTINES (OSTERTAGIA AND NEMATODIRUS).

It is believed that roundworms are responsible in a large measure for unthriftiness in young reindeer. Anemic fawns have been examined where no other parasites or disease could be held responsible for their lack of condition. The worms are small, the *Ostertagia* in the stomach being as fine as hair, but sometimes occurring in such numbers as to give the lining of the fourth stomach a reddish appearance. The *Nematodirus* worms in the intestine are larger and belong to two different undescribed species. They have been found in a number of cases in young reindeer, sometimes occurring in large numbers. These intestinal roundworms have a direct life history; the eggs are passed out with the feces and hatch upon the ground, and the larvae are then picked up by reindeer. Close and frequent grazing over the same ground will predispose animals to becoming heavily infested by these parasites.

PREVENTION AND TREATMENT OF WORMS.

No attempts at the drug treatment of reindeer for worms have as yet been made. Prevention, however, has been essayed in a small way on reindeer allotments. If reindeer owners follow the recommendations made in the fore part of this bulletin about rotation and open grazing, they will materially cut down the losses from worms. The following examples serve to show how proper range management may prevent losses and improve the condition of a herd:

During the winter of 1920–21 definite proof through post mortems was obtained that a small herd of about 1,400 reindeer was heavily infested with a variety of parasites. The native owner reported that during the previous summer he had lost 100 fawns from sickness. The parasites which were found in his animals included three kinds of tapeworms, cysts derived from dogs, and several species of roundworms. The owner was advised to treat his herd dogs for the removal of tapeworms. He was also told that his animals must have been grazing for too long a period over the same area. This he admitted to be the case, and stated that when he first came to his allotment his deer were much admired for their size and condition. He had remained on the allotment for the past eight years, but during the last four seasons he had noticed that his animals were losing in condition year by year and his losses had reached a point where they were causing him grave concern. He was advised to find new grazing ground during the following summer and to keep his animals moving, so that they would not remain over two weeks on a given area. The herd was reinspected during the latter part of September, 1921, and it was gratifying to note that the animals had

improved very greatly in size and condition. The owner stated that his losses in fawns during the summer had been only six animals.

Further support can be brought to show that this improvement was not mere accident. Some 200 animals belonging to this herd were removed early in the season to another allotment. These were also inspected during September, and four fawns and two adults were killed on account of skin troubles (dermatitis). The fawns were found quite free from evidence of tapeworm infection, that is, those forms which are derived from dogs, and no other worms were found in the animals. It is, of course, possible that a few minute worms may have been overlooked, but the fact remains that the fawns were clean and healthy in every particular, except for the aforementioned skin troubles. At the same time, the two older reindeer which were slaughtered still harbored a considerable number of parasites. The obvious lesson to be derived from this experience is that once reindeer are infected with parasites, they are apt to retain some species for long periods and to be capable of passing them on to other animals, especially the young, providing they are kept in close contact, or, in other words, close herded for too long periods on the same piece of ground.

In the example just cited we have a herd full of parasites. The animals are put on new ground and are kept constantly moving at two-week intervals during the warm months, when parasites are most readily transferred. The fawns grow up strong and healthy without parasites, though their mothers are infected. The reason for this healthy condition and freedom from parasites is that the worms which leave the mother reindeer in her feces take some days to hatch upon the ground and to reach a stage where they are ready to infect new hosts. It is hoped that future investigations will yield definite facts as to the exact time required for the various parasites to hatch on the ground and become infective for other animals. At the present time, and until proper open herding methods are used, it is recommended that during the warm season, particularly from June to the end of September, the herds be moved at least every two weeks to fresh ground and that the animals be not brought back to graze on areas which have been considerably used earlier in the season. Worm larvae are very resistant and will remain on the ground for long periods waiting to attack their hosts.

WARBLE FLIES (OEDEMAGENA TARANDI).

The warble fly of reindeer is a beelike insect of yellowish orange coloration. The life history will be given only briefly in this bulletin, as it is proposed to publish later a more detailed account of the insect. The fly is on the wing in the latter part of June and has

been captured as late as September 9, so that its season of activity covers three months in favorable years. Being an arctic species, it can withstand much more cold and wet than southern species of warble flies. The eggs are laid mainly on the fine, woolly hairs which constitute the under down of a reindeer coat, principally on the parts which come in contact with the soil when the animal lies down; this means the flanks, brisket, and the upper part of the legs.

The fly lays its eggs both when reindeer are standing and lying down. When it lays on standing animals it causes them much uneasiness, and during hot weather it is common to see a herd "milling" or moving round and round in circles. Some of the animals will be seen running, others kicking and stamping; meanwhile the fawns will be uttering their grunting plaints of *oh-oh-oh*. The whole scene gives the impression of worry and unrest and makes one feel as the great Linnaeus did when he first saw these flies at work in Lapland, that even a small insect can bring much trouble into the world. Fortunately, the warble fly does not always keep the animals so restless. When the herd is resting the flies adopt gentler tactics, and they may be seen on the ground busily depositing their eggs on the reindeer hair without causing any annoyance other than, perhaps, a slight tickling at times. In this case the insect backs up, gently pushes its long ovipositor into the hair, and lays its eggs without necessarily alighting on the deer.

Experimentally, the eggs have been found to hatch in 6 to 7 days, and the young larvae to bore through the skin. Though this act of boring has not been witnessed in reindeer, there is no doubt that the grubs do go through the skin. They have been found in large numbers just under the skin, and as many as 107 were counted on one hind and one front leg of one animal. These young grubs are very minute, and numerous examples about 1 millimeter in length were found. The grubs may be found on the legs and body quite early in the season, and in 1921 they were seen as early as August 4.

There is a definite migration of the larvae from the point of entrance toward the back.[17] The first grubs to reach the back and bore through to the outside were found on September 26. These were two in number. A week or two later hides may be found with numerous punctures. It is not until toward the end of October that the holes through the skin attain any size. However, even the smallest hole causes an irreparable injury when a skin is tanned.

[17] In an unpublished report of 1914, Joss recorded the finding of two small warble larvae along the gullet. This is of interest in that in the present investigation larvae were not encountered in this position. In Bergman's investigations in Sweden there are no records of the larvae being found inside the body cavities. It is possible that the larvae which Joss found may have been erring or lost. In the present investigation in Alaska, larvae were encountered deep in the muscles, having evidently taken a wrong course in their migration to the back.

The larvae grow progressively and evenly in size until May, and the earliest grubs emerged (1921) on May 12. It is quite likely that a very few may come out prior to this date, and not many are left behind in the skin on July 1. The time of greatest emergence of grubs is during June.

The larvae pupate, or harden, in a day or two, depending upon the state of moisture surrounding them. There are no satisfactory records for Alaska as to the average period required for the emergence of the fly. In trials which were made in 1921, the pupae were kept too moist, owing to unavoidable circumstances, so that though a few of the flies emerged, they did so after a lengthened interval. Bergman states that in Sweden the pupal stage averages about 27 days.[18] No doubt in Alaska it will be found that the period is of similar length.

The damage done by warble flies is difficult to estimate. In Alaska, though reindeer are sometimes burdened with several hundred larvae in their backs, and in rare cases may have as many as a thousand (Pl. XXIV), it seems that there is considerable tolerance of the parasites by the animals. In other words, the reindeer support a large number of warble larvae without showing much suffering or loss of condition. That there is a defensive reaction on the part of the reindeer against the grubs is shown by the fact that the yearlings have the most larvae, but when they reach 3 years of age it often happens that they have only a few grubs, and when adult life is reached at 5 or 6 years they may escape altogether. The reaction on the part of reindeer to warble larvae is manifested by the formation of pus and by the production of a sac which incloses the grub after it has taken up its permanent place of abode on the back. The amount of pus secreted is not so great as is that secreted by cattle against *Hypoderma*, the cattle warble-fly.

Reindeer skin is very thin and the larvae make a large opening at the time they are ready to leave the body. These openings, together with the presence of pus, expose the yearling reindeer, especially, to the attacks of screw worms. It has been found that it is a very simple matter to extract the larvae by squeezing the skin. This causes the reindeer little pain and the operation is quickly done. If the yearlings were thus treated in April and May, danger from screw worms would be eliminated almost entirely, as the cavities in the backs would have healed before the blow flies appear, which is at a later date.

The suggestion has been made that does be separated from the rest of the herd at fawning time. When this is done, the bucks and

[18] Bergman, Arvid, On the Oestridae of reindeer: Entomologisk Tidskrift, vol. 38, pp. 1–32, 113–146, 1917.

yearlings can be driven into the corral, and the young animals treated during the fawning season. Extraction of the grubs is apparently a safe procedure. Experiments were made to determine whether injection of the juices contained in the larvae would seriously affect the reindeer. While some slight results were obtained, it was proved in a few cases that reindeer can withstand large doses of the warble fluids. In the latter part of April and early in May the warble grubs are large, and their skin is very tough, so that it is unlikely that they would be ruptured during the process of removal. Besides, as a reindeer skin is soft and pliable, the squeezing out of the grubs presents no difficulty. Theoretically, if all warble larvae were thus squeezed out and destroyed, there should be no flies left to attack the animals. Unfortunately, warble flies are able to travel long distances, and seem to have the power of following animals and of catching up with a herd.

It was suggested to one reindeer owner some years ago that he try the following method: After most of the grubs have left the reindeer, about July 1, drive the animals as far away as possible from the point where the grubs have fallen, the idea being that when the flies emerged from the pupal cases they would not find any reindeer to attack, and as they only live for a few days they would soon die. The owner, A. H. Twitchell, reported a measure of success from following this method; and, when his herd was visited, it was remarked that the hides seemed to be less affected with warbles than those seen in other herds. It is thought that the distance which reindeer must be driven should be not less than 15 miles, but the point has not been definitely settled.

In connection with the elimination of warble flies it is interesting to note that the St. Lawrence Island herd has been free from warbles ever since it was established. The reindeer were derived from the same sources as the other Alaskan herds. It would appear that they may have been transported to the island after all the grubs had left their backs and before egg-laying had started. St. Lawrence Island was visited during the summer of 1921 and the matter was investigated. No sign of either *Oedemagena tarandi* or *Cephenomyia nasalis*, the nostril fly, was seen.

Lapp names for *O. tarandi* are as follows: The larva is called gourma or gourbma; and the imago or fly, batta-bosska.

NOSTRIL FLIES (CEPHENOMYIA NASALIS) (C. TROMPE).

The nostril fly of reindeer is a blackish beelike insect with a round abdomen. Its habits are quite unlike the warble fly, and it causes far more annoyance to reindeer than the latter. It has about the same seasonal activity as the warble fly, or from June to September, but

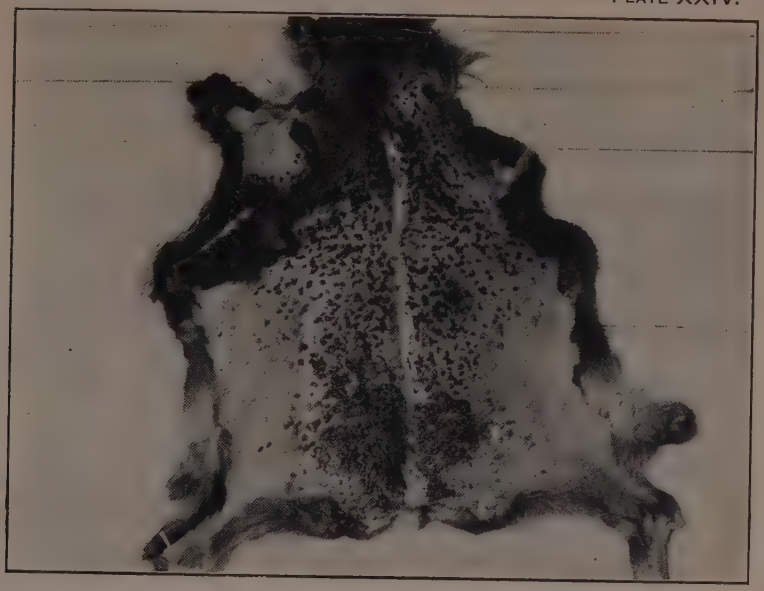

FIG. 1.—YEARLING SKIN INFESTED WITH WARBLE GRUBS. B22607

About 1,000 larvae of the warble fly (*Oedemagena tarandi*) were counted on the back. With such a number the hide was practically riddled, one hole being punctured by each grub. More parasites were counted on the right side than on the left.

FIG. 2.—NEAR VIEW OF ABOVE SKIN.

In a line along the backbone the skin is free from grubs, explained, no doubt, by the pressure and movements of the bone.

is never so numerous. Instead of laying eggs, it deposits live larvae in the nostrils of reindeer.

The method of attack is peculiar. The fly hovers for a few moments in front of the nostrils, then darts in and deposits a drop of wriggling larvae at the entrance to the nose. The larvae work their way up the nostrils and attach themselves at the back just in front of the entrance to the throat.

The effect on reindeer of this method of larval deposition is most marked. The animals are terrified by the insect's attack, and when it is hovering in front of their noses they assume a terror-stricken look, their eyes staring, their mouths open, and their bodies in a tensely strained attitude. When a reindeer is in this rigid state, the slightest touch on any part of the animal will cause muscular contractions which shake the whole body, just like an electric shock. When the insect deposits its larvae, such a shock follows. It is succeeded by a total relaxation, the deer evidently realizing that it is not likely to be struck twice by the same insect. The animal appears nauseated and walks a few steps with its head elevated, sneezing and showing signs of nasal irritation.

Once the larvae are firmly attached in their habitat at the back of the nostrils, they seem to cause the reindeer very little annoyance. Their growth is slow and they do not greatly increase in size until about the end of March, at which time they appear to grow most rapidly, attaining their full size in the early part of May. The first larva seen to emerge appeared on May 12. The last date of emergence has not been ascertained definitely, but presumably it is about the same as for the warble fly.

When the larvae are mature they cause the reindeer much suffering and annoyance. Two young animals which were kept at the Unalakleet station were watched carefully, and it was observed that the larvae kept them in a constant state of worry, even when they were at rest. They would elevate their heads and sniff in an evident attempt to dislodge the parasites. At other times they coughed and sneezed. But though these attempts to dislodge the parasites were almost continuous, the reindeer seldom appeared to use really vigorous efforts, apparently owing to fear. The expulsion of the larvae was observed on several occasions, and almost invariably when a larva fell to the ground it was red in color, being coated with a thin film of blood.

It is surprising to note that nasal discharges in reindeer are slight in comparison with those of sheep when the latter are harboring *Oestrus ovis*, which is very similar to the reindeer fly in habits. Reindeer, however, show symptoms of staggers, or "false gid," such

as are seen in sheep, a form of dizziness induced no doubt by the irritation caused by the larvae. Bergman mentions a disease called "varka" in Lapland which he attributes to *Cephenomyia nasalis* and which he says may cause death.[19] In Alaska there are no records of reindeer dying from grubs in the nose, but it is quite possible that occasional deaths do occur.

After the larva has fallen to the ground it pupates rapidly, in five or six hours as a rule. It differs in this respect from *Oedemagena tarandi*, which is much slower. The pupal period is shorter than it is for *O. tarandi*. According to Bergman, the pupal stage may be from 16 to 31 days. In observations made in Alaska, the pupal period lasted up to 56 days, but this was under adverse conditions, and only 20 flies emerged out of a total of 54 pupae.

The treatment or prevention of nostril flies seems even more hopeless than is the case with warble flies. The only means of prevention that seems at all likely to succeed would be to provide darkened shelters for the reindeer to go into when the flies are attacking them. In northern Europe, especially on the Finnish side in Lapland, long dark sheds are provided, and the Lapps say that without such protection reindeer would suffer greatly in some districts. Shelters would be most helpful against the warble fly as well and would also afford the reindeer some protection from other forms of insect life. Unfortunately, in arctic latitudes the insects are at work the greater part of the 24 hours; consequently, during the hot weather the reindeer might not get very much chance for feeding. But on the other hand, if the animals have no means for protecting themselves they suffer so much annoyance and worry that the loss of a little food would seem preferable.

Lapp names for *Cephenomyia nasalis* are as follows: The larva is called saula; and the imago or fly, boaro.

SCREW WORMS (PHORMIA TERRAE-NOVAE).

Blowflies are found in abundance on all the reindeer allotments. Both natives and whites are careless in the disposition of refuse; consequently, on approaching a reindeer herder's cabin, swarms of blowflies may be seen rising from rubbish heaps containing reindeer offal, fish refuse, and other offensive material. Reindeer that die on the range are usually left where they lie. It is no wonder, therefore, that wounds may become infected with screw worms. A heavily infected skin taken from a reindeer on May 20 is illustrated in Plate XXII, Figure 2.

The most important factor predisposing reindeer to infestation with screw worms in the warble fly. When the warble larvae emerge

[19] Bergman, Arvid, On the Oestridae of reindeer: Entomologisk Tidskrift, vol. 38, pp. 1–32, 113–146, 1917.

from the reindeer in spring large openings (in some cases, hundreds) filled with pus may be seen in their backs. Blowflies are attracted to these and it is reported that in some seasons considerable losses may follow blowfly attack. Prevention of this form of loss has been discussed under Warble Flies, p. 61.

Screw worms have been found infesting wounds resulting from other causes, such as broken horns and sores on the legs. In these cases the removal of the grubs and the surgical treatment of wounds will bring about a cure. Proper disposal of refuse and carcasses should bring about a diminution of blowflies. Burning is the most satisfactory method, and next to this comes burial; in Alaska, however, owing to the frozen state of the ground, burial is not always possible, and fuel for burning is sometimes scarce. When burial is possible, at least 2 feet of soil should cover the carcass. Lime and oil are of assistance in the destruction of larvae and may be used to advantage. A carcass soaked in oil can be set fire to and many grubs thus destroyed. Cleanliness around native villages could easily be enforced, and the reprehensible practice of throwing carcasses of dead dogs on the seashore should be stopped. It is true that many dogs have to be killed each spring, but the work should be done under supervision and the animals should be burned or properly buried.

MOSQUITOES.

Mosquitoes are a serious pest in the north and cause much annoyance to man and beast. In Alaska they consist of only a few species, although they are very numerous. Reindeer suffer a great deal from the mosquito, but being so heavily coated they appear to resist attack better than do some animals, excepting during the time when their hair is newly shed.

Culiseta alaskaensis Ludlow[20] and *C. impatiens* Walker are the large snow mosquitoes which come out early in spring. *Aedes punctodes* Dyar is the common form, and is the worst mosquito attacking reindeer on the coast of Alaska, where it appears about the latter part of June. The Lapps always say that the mosquitoes help them to round up their herds at marking time, about June 20; it is probable, however, that the warble fly, which appears about that time, may also play a part. According to Dyar, *Aedes cataphylla* Dyar, of which a few specimens were collected on the coast, is the species which is abundant along the Yukon Valley.

LICE.

The only surface-skin parasites of reindeer found up to the present time are lice, and these have been encountered in only small numbers.

[20] Determinations of the mosquitoes collected in Alaska were made by Dr. H. G. Dyar, of the Bureau of Entomology.

While lice in cattle are more numerous in certain seasons, it was not observed that the reindeer were bothered to any extent in Alaska. Reindeer men report that they have at times noticed a loss of hair in reindeer which may have been due to attacks of lice.

PROTOZOA.

The Protozoa found in reindeer require further study. *Sarcosporidia* in the muscles are of common occurrence. In cattle and sheep these parasites are usually regarded as having little significance, but in reindeer there are some cases at least where the numbers of the cysts are so great that value of the meat is lowered. A disease called by reindeer men "cornmeal," which is also caused by Protozoa,[21] is noticed when affected animals are skinned; there is found to be a decided roughening of the bones and tendons, hence the name "cornmeal." It would be difficult to detect these cases in the live animals. Young reindeer do not seem to be infested, or only to a slight extent. The old animals are the most heavily parasitized.

PATHOLOGICAL CONDITIONS IN GENERAL.

In the survey of the reindeer industry in Alaska, no serious outbreaks of contagious diseases were encountered. It would seem that reindeer are more fortunate than either cattle or sheep in this regard.

Parasites are undoubtedly the worst enemies reindeer have, and fortunately the outlook for controlling some species seems hopeful. For instance, the worms which reindeer derive from dogs can be reduced simply by treating the dogs with vermifuges. The remedy lies in the hands of the reindeer owners.

Bacterial diseases, such as foot rot, have been mentioned in the preceding paragraphs; there are, however, several other bacterial diseases requiring further investigation, such as lung affections and diseases of the heart.

Septic conditions of lungs and the coverings of the heart are not uncommon. It may be found that these cases are brought on mechanically by the penetration of foreign bodies from the paunch. In those cases which were examined for bacteria, a variety of organisms were encountered.

In concluding this chapter on disease, it will be well to caution all reindeer men against keeping sickly animals in their herds. *If there is any doubt about an animal, it should be killed without hesitation. Great losses may often be averted by prompt action of this nature.*

[21] Cf. Hadwen, Seymour, Cyst-forming Protozoa in reindeer and caribou: Journ. Amer. Vet. Med. Assn., vol. 61, n. s. vol. 14, no. 4, pp. 374–382, figs. 1–8, July, 1922. In this article the parasite of "cornmeal" disease is described, and named *Fibrocystis tarandi*.

SUMMARY.

Alaskan reindeer are derived from the original importations of 1,280 animals from Siberia by the Bureau of Education during 11 years beginning in 1892. In 30 years the herds have increased to from 130,000 to 200,000, and probably 100,000 additional have been killed for meat and skins. It is estimated that grazing areas in Alaska will support from 3,000,000 to 4,000,000 head. The herds are owned chiefly by natives, for whose use they were originally imported, but white men have gradually acquired stock, and under their management the conditions of both their own herds and those of the natives should improve.

From a preliminary survey of grazing, range, and herd management and of diseases and parasites, made possible under an appropriation which became available on July 1, 1920, it is evident that the development of the reindeer industry requires white supervision, with proper markets, improved transportation and cold storage facilities, grazing on the system of allotted ranges, improvement of herd management, enactment and enforcement of a brand registry law, and the control of diseases and parasites.

Efficient range management involves attention to the carrying capacity of the range, with an avoidance of both overgrazing and undergrazing, the former being detrimental to the reindeer and the latter being wasteful.

Company herds are advocated, in which ownership of does shall be the basis of dividends and of cost assessments.

Distribution of the herds over the range may be improved by salting. Line fencing between range allotments may in some cases be advisable, but this will not take the place of efficient herding.

The experiment of crossing reindeer does with caribou bulls is contemplated for grading up the stock and increasing weights. Old and scrubby does as well as the same quality of bucks must be eliminated and better bucks must head the herds to increase the average size of the fawns. White reindeer are deficient in vitality and size, and while an aid in locating a herd, are undesirable and should not be permitted to breed.

Rough handling of herds in round-ups and corrals must be eliminated to lessen accidents and fatalities.

Notching ears as a means of identification is unsatisfactory and if possible should be superseded or accompanied by branding.

Dehorning reindeer was tried without success. Castration of bucks after the velvet has been shed causes the horns to drop. Modern methods of castration should take the place of those heretofore practiced by the Lapp and Eskimo herders.

Rutting starts August 25 and ends in October. Reindeer should be held in good grazing areas during this period and in the fawning season. Experiments demonstrate that reindeer may be fed like cattle, but this would probably not be an economic success.

While no serious contagious diseases of reindeer have occurred in Alaska, control of certain diseases and of parasites must be undertaken. Killing diseased reindeer promptly is recommended to prevent spread of contagion in the herds.

The warble fly (*Oedemagena tarandi*) is a serious reindeer parasite, damaging the hides and causing abscesses on the legs. Tapeworm cysts, for which dogs are responsible, will disappear in reindeer by proper treatment of dogs.

Reindeer meat is at its best in autumn, and the right time for slaughtering is in October and November. Earlier than this the back fat is not fully laid on, and later the parasitic larvae depreciate the value of the meat.

The reindeer industry in Alaska promises to become a large factor in the development of the Territory and should be encouraged in every practicable manner.

CHECK LIST OF ALASKAN RANGE PLANTS.

The following list includes the plants that have been identified as occurring on the reindeer range of the coast lying between Point Hope and Kuskokwim Bay, including Nunivak and St. Lawrence Islands. This list is compiled largely from collections made during the investigations and in part from the collection of Charles Thornton, of Nome, Alaska, a local botanist.

GRASSES.

Agropyron sericeum (wheatgrass).
Agrostis aequivalvis (redtop).
Agrostis borealis (redtop).
Alopecurus alpinus (foxtail).
Arctagrostis latifolia.
Calamagrostis scabra (coast bluejoint).
Elymus arenarius (dunegrass).
Elymus mollis (dunegrass).
Festuca rubra (red fescue).
Festuca rubra barbata (fescue).
Festuca rubra subvillosa (fescue).
Phleum alpinum (wild timothy).
Poa arctica (bluegrass).
Poa eminens (giant bluegrass).
Poa hispidula (bluegrass).
Trisetum spicatum.

GRASSLIKE PLANTS.

Carex aquatilis (sedge).
Carex atrofusca (sedge).
Carex canescens (sedge).
Carex compacta (sedge).
Carex concolor (sedge).
Carex helconastes (sedge).
Carex lachenalli (sedge).
Carex macrochaeta (sedge).
Carex membranacea (sedge).
Carex rotundata (sedge).
Carex scirpoides (sedge).
Equisetum arvense (horsetail).
Equisetum palustre (horsetail).
Equisetum sylvaticum (horsetail).
Eriophorum angustifolium (large cotton sedge).

Eriophorum callitrix (small cotton sedge).
Eriophorum vaginatum (cotton sedge).
Juncoides arcuatum (wood rush).
Juncoides campestre (wood rush).
Juncoides kjellmannianum (wood rush).
Juncus castaneus (rush).
Juncus haenkei (rush).
Sparganium hyperboreum (bur-reed).
Torresia alpina (sedge).
Zostera marina (eelgrass).

WEEDS (HERBACEOUS PLANTS).

Achillea borealis (yarrow).
Aconitum delphinifolium (monkshood).
Allium sibiricum (onion).
Alsine (stellaria).
Amsinckia menziesii (fiddleneck).
Androsace chamaejasne.
Anemone multiceps (anemone).
Anemone narcissiflora (anemone).
Anemone parviflora (anemone).
Anemone richardsoni (anemone).
Antennaria borealis (everlasting).
Antennaria monocephala (everlasting).
Arenaria arctica (sandwort).
Arenaria macrocarpa (sandwort).
Arenaria verna (sandwort).
Arnica alpina (arnica).
Arnica nutans (arnica).
Arnica obtusifolia (arnica).
Arnica unalaschensis (arnica).
Artemisia arctica (wormwood).
Artemisia semavinensis (wormwood).
Artemisia tilesii (wormwood).
Aster sibiricus (aster).
Astragalus alpinus (loco).
Astragalus littoralis (loco).
Barbarea barbarea (wintercress).
Barbarea orthocerus (wintercress).
Bupleurum americanum (hare's-ear).
Caltha nutans (marsh marigold).
Caltha palustris arctica (marsh marigold).
Campanula lasiocarpa (bellflower).
Campanula rotundifolia (bellflower).
Campanula uniflora (bellflower).
Campe (barbarea).
Capnoides pauciflorum.
Capsella bursa-pastoris (shepherd's-purse).
Cardamine bellidifolia (bittercress).
Cardamine blaisdellii (bittercress).
Cardamine pratensis (bittercress).
Cardamine purpurea (bittercress).
Cardamine unbellata (bittercress).
Castilleja tristis (paintbrush).
Cerastium alpinum (chickweed).
Cerastium arcticum (chickweed).
Cerastium minimum (chickweed).
Cheirinia cheiranthoides (wallflower).
Chrysanthemum arcticum (daisy).
Chrysanthemum integrifolium (daisy).
Chrysosplenium beringianum (golden saxifrage).
Chrysosplenium tetandrum (golden saxifrage).
Cicuta douglasii (water hemlock).
Claytonia eschscholtzii (spring beauty).
Claytonia sarmentosa (spring beauty).
Claytonia tuberosa (spring beauty).
Cochlearia fenestrata (spooncress).
Cochlearia oblongifolia (spooncress).
Coelopleurum gmelini (parsnip).
Conioselinum gmelini (hemlock parsley).
Delphinium blaisdellii (larkspur).
Delphinium brownii (larkspur).
Dianthus repens (pink).
Dodecatheon frigidum (shooting star).
Draba alpina (whitlow).
Draba borealis (whitlow).
Dryas octopetala (dryad).
Epilobium anagallidifolium (willow-weed).
Epilobium angustifolium (common fireweed).
Epilobium bongardi (willow-weed).
Epilobium latifolium (broadleaf willow-weed).
Erigeron hyperboreus (daisy).
Erigeron uniflorus (daisy).
Eritrichum arctioides (Arctic forget-me-not).
Galium boreale (bedstraw).

Gentiana frigida (gentian).
Gentiana glauca (gentian).
Gentiana propinqua (gentian).
Gentiana prostrata (gentian).
Gentiana tenella (gentian).
Habenaria bracteata (orchid).
Habenaria hyperborea (orchid).
Habenaria obtusata (orchid).
Hedysarum americanum (jointpod).
Hedysarum mackenzii (jointpod).
Heracleum lanatum (cow parsnip).
Heterotrichum monticola (purple aster).
Heterotrichum subsinuatum (purple aster).
Hippurus vulgaris (marestail).
Iris setosa (Arctic iris).
Lagotis minor.
Lathyrus maritimus (beach pea).
Leontodon lyratum (dandelion).
Leontodon taraxacum (dandelion).
Lesquerella arctica (bladderpod).
Ligusticum macouni (Macoun lovage).
Ligusticum scothicum (Scotch lovage).
Linnaea borealis (twinflower).
Lloydia serotina.
Lomatogonium rotatum.
Lupinus (lupine).
Lychnis apetala (campion).
Matricaria criscoidea (camomile).
Matricaria hookeri (camomile).
Menyanthes trifoliata (buckbean).
Merckia physodes (water starwort).
Mertensia eastwoodae (bluebells).
Mertensia paniculata (timber bluebells).
Moehringia lateriflora (trailing sandwort).
Montia rivularis (spring beauty).
Myosotis alpestris (forget-me-not).
Nasturtium palustre (marshcress).
Oxyria digyna (mountain sorrel).
Oxytropis campestris (oxytrope).
Oxytropis mertensiana (oxytrope).
Oxytropis nigrescens (oxytrope).
Oxytropis podocarpa (oxytrope).
Oxytropis sewardensis (oxytrope).
Papaver nudicaule (Iceland poppy).
Papaver nudicaule multiceps (Iceland poppy).
Parnassia kotzebuei.
Parnassia palustris.
Parrya nudicaulis (Parry mustard).
Pedicularis arctica (fernweed).
Pedicularis capitata (fernweed).
Pedicularis labradorica (fernweed).
Pedicularis langsdorfii (fernweed).
Pedicularis pervifiora (fernweed).
Pedicularis sudetica (fernweed).
Pedicularis versicolor (fernweed).
Pedicularis verticillata (fernweed).
Pentstemon procerus.
Petasites frigida (butterbur).
Phlox sibirica (phlox).
Pinguicula vulgaris (butterwort).
Pneumaria maritima (beach bluebells).
Polemonium acutiflorum.
Polemonium humile.
Polygonum alaskanum (smartweed).
Polygonum aviculare (knotweed).
Polygonum bistorta (smartweed).
Polygonum plumosum (smartweed).
Polygonum viviparum (smartweed).
Potentilla biflora.
Potentilla egedii (fivefinger).
Potentilla elegans (showy fivefinger).
Potentilla emarginata (fivefinger).
Potentilla fruticosa (shrubby cinquefoil).
Potentilla nivea (small woolly cinquefoil).
Potentilla palustris (marsh fivefinger).
Potentilla uniflora (fivefinger).
Primula borealis (primrose).
Primula egaliksensis (primrose).
Primula eximia (primrose).
Primula sibirica (primrose).
Pyrola grandiflora.
Radicula palustris (yellow cress).
Ranunculus chamissonis (buttercup).
Ranunculus hyperboreus (buttercup).
Ranunculus nivalis (buttercup).
Ranunculus pallasii (water buttercup).
Ranunculus pygmaeus (buttercup).
Ranunculus sceleratus (buttercup).
Ranunculus sulphureus (buttercup).
Ranunculus verticillatus (buttercup).
Rhinanthus crista-galli (yellow rattle).
Rumex acetosa (sour dock).
Rumex occidentalis (dock).
Rumex occidentalis nanus (dock).
Sagina saginoides (pearlwort).
Sanguisorba microcephala (burnet).
Sanguisorba sitchensis (Alaska burnet).
Saussurea monticola (sawwort).
Saxifraga bracteata (saxifrage).

Saxifraga bronchialis (saxifrage).
Saxifraga cernua (saxifrage).
Saxifraga eschscholtzii (saxifrage).
Saxifraga flagellaris (saxifrage).
Saxifraga foliolosa (saxifrage).
Saxifraga hieracifolia (saxifrage).
Saxifraga hirculus (saxifrage).
Saxifraga neglecta (saxifrage).
Saxifraga nelsoniana (saxifrage).
Saxifraga oppositifolia (saxifrage).
Saxifraga radiata (saxifrage).
Saxifraga rivularis (saxifrage).
Saxifraga serpyllifolia (saxifrage).
Saxifraga unalaschensis (saxifrage).
Sedum integrifolium (stonecrop).
Senecio atropurpureus (senecio).
Senecio frigidus (senecio).
Senecio lugens (senecio).
Senecio palustris (senecio).
Senecio pseudo-arnica (senecio).
Senecio resedifolius (senecio).
Senecio thorntoni (senecio).
Senecio walpolei (senecio).
Sieversia glacialis.
Sieversia rossii.
Silene acaulis (moss campion).
Smelowskia calycina.
Solidago multiradiata (goldenrod).
Sophia sophioides (tansy mustard).
Statice arctica (thrift).
Stellaria longipes (starwort).
Stellaria media (starwort).
Thalictrum alpinum (meadow rue).
Tofieldia coccinea (false asphodel).
Tofieldia palustris (false asphodel).
Trientalis europaea arctica (star-flower).
Valeriana capitata (valerian).
Veratrum spicatum (false hellebore).
Veronica stelleri (speedwell).
Vicia (vetch).
Viola biflora (violet).
Viola palustris (violet).
Zygadenus elegans (death camas).

BROWSE (WOODY PLANTS).

Alnus alnobetula (alder).
Andromeda polifolia (bog rosemary).
Arctous alpina (alpine bear-berry).
Betula kenaica (birch).
Betula rotundifolia (ground birch).
Cassiope tetragona (moss heather).
Cornus suecica (herb dogwood).
Diapensia lapponica (diapensia).
Empetrum nigrum (crowberry).
Ledum decumbens (Alaska tea).
Ledum groenlandicum (Alaska tea).
Ledum palustre (Alaska tea).
Rhododendron lapponicum (rhododendron).
Ribes triste (red currant).
Rosa acicularis (rose).
Rubus arcticus (Arctic raspberry).
Rubus chamaemorus (salmonberry).
Salix arctica (Arctic willow).
Salix fuscescens (bog willow).
Salix glauca (grayleaf willow).
Salix phlebophylla (skeleton willow).
Salix pulchra (diamondleaf willow).
Salix reticulata (netleaf willow).
Salix richardsonii (Richardson willow).
Salix rotundifolia (roundleaf willow).
Spiraea steveni (spiraea).
Vaccinium oxycoccus (small cranberry).
Vaccinium uliginosum (blueberry).
Vaccinium vitis-idaea (mountain cranberry).
Viburnum pauciflorum (highbush cranberry).

FERNS AND FERN ALLIES.

Dryopteris dilatata (shield fern).
Dryopteris fragrans (shield fern).
Filix fragilis (brittle fern).
Filix montana (brittle fern).
Lycopodium alpinum (clubmoss).
Lycopodium annotinum (clubmoss).
Lycopodium selago (clubmoss).
Selaginella schmidtii (selaginella).
Woodsia glabella.

MOSSES.

Aulacomnium palustre (bunch moss).
Aulacomnium turgidum (bunch moss).
Brachythecium rivulare.
Bryum albicans (common moss).
Bryum bimum (common moss).
Calliergon alaskanum.

Calliergon cuspidatum.
Climacium americanum.
Dicranum bonjeani (pad moss).
Dicranum elongatum (pad moss).
Dicranum groenlandicum (pad moss).
Dicranum neglectum (pad moss).
Dicranum scoparium (pad moss).
Drepanocladus fluitans (fern moss).
Drepanocladus uncinatus (fern moss).
Funaria hygrometrica.
Hylocomium alaskanum (timber fern moss).
Hylocomium proliferum (timber fern moss).
Hypnum schreberi.
Leptobryum pyriforme.
Mnium glabrescens.
Paludella squarrosa.
Philonotis fontana.
Polytrichum commune (heath moss).
Polytrichum hyperboreum (heath moss).
Polytrichum juniperinum (heath moss).
Polytrichum piliferum (heath moss).
Polytrichum strictum (heath moss).
Polytrichum yukonense (heath moss).
Psilopilum arcticum.
Psilopilum glabratum.
Ptilidium ciliare.
Rhacomitrium lanuginosum.
Sphagnum angstroemii (sphagnum moss).
Sphagnum capillaceum tenellum (sphagnum moss).
Sphagnum fimbriatum (sphagnum moss).
Sphagnum girgensohnii (sphagnum moss).
Sphagnum magellanicum (sphagnum moss).
Sphagnum lindbergii (sphagnum moss).
Sphagnum plumosum (sphagnum moss).
Sphagnum riparium (sphagnum moss).
Sphagnum squarrosum (sphagnum moss).
Tetraplodon nimioides.

LICHENS.

Alectoria nigricans (black lichen).
Alectoria ochroleuca (black lichen).
Cetraria cucullata (Iceland moss).
Cetraria islandica (Iceland moss).
Cetraria islandica crispa (Iceland moss).
Cetraria juniperina (Iceland moss).
Cetraria juniperina terrestris (Iceland moss).
Cladonia alpestris (reindeer moss).
Cladonia amaurocraea (reindeer moss).
Cladonia bellidiflora (reindeer moss).
Cladonia coccifera (reindeer moss).
Cladonia coccifera pleurota (reindeer moss).
Cladonia coccifera stemmatina (reindeer moss).
Cladonia deformis extensa (reindeer moss).
Cladonia furcata (reindeer moss).
Cladonia gracilis elongata (reindeer moss).
Cladonia rangiferina (reindeer moss).
Cladonia sylvatica (reindeer moss).
Cladonia sylvatica sylvestris (reindeer moss).
Cladonia turgescens (reindeer moss).
Cladonia uncialis (reindeer moss).
Dactylina arctica.
Gyrophora arctica (broadleaf lichen).
Haematomma ventosum.
Icmadophila ericetorum (white pad-moss).
Lobaria linita.
Nephroma arcticum (ear lichen).
Ochrolechia tatarea.
Pertusaria bryontha.
Solorina crocea.
Stereocaulon paschale.
Stereocaulon tomentosum
Stereocaulon wrightii.

FUNGI.

Hydnum imbricatum (mushroom).
Polyporus elegans.
Scutula stercocaulorum.

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